2021 Stevens Creek Fisheries Monitoring

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Reports included:

2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Stevens Creek

Appendix A: 2020 – 2021 Stevens Creek Stream Temperature Monitoring

Appendix B: 2021 Stevens Creek Central California Coast Steelhead (*Oncorhynchus mykiss)* Fish Condition Analysis

Stevens Creek *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags

Appendix A: PIT Tag Master List

Stevens Creek 2020 – 2021 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Fremont Fish Ladder

2021 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Stevens Creek



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January 2022

Executive Summary

Valley Water began index reach monitoring for juvenile *Oncorhynchus mykiss* in Stevens Creek in 2020 to document the abundance, distribution, and densities of *O. mykiss*, as well as fish species composition. The Stevens Creek juvenile rearing monitoring is part of a larger effort to assess and monitor trends of *O. mykiss* populations throughout Santa Clara County. Similar sampling began in the Guadalupe River Watershed in 2018, and the Coyote Creek Watershed in 2019. The monitoring of Stevens Creek was authorized under a National Marine Fisheries Service (NMFS) Section 10(a)(1)(A) recovery permit and a California Department of Fish and Wildlife (CDFW) Scientific Collecting Permit in 2018. In 2021, data collection occurred under NMFS Section 10(a)(1)(A) Recovery Permit number 16417-3M and CDFW Scientific Collecting Permit, Specific Use Permit number S-191480002-21124-001.

This marks the second year of juvenile rearing monitoring in Stevens Creek. In fall 2021, sampling was conducted at four stations (SC004, SC005, SC006, and SC BONUS). The downstream stations (SC001 to SC003) were dry and therefore sampling could not occur at these locations. Similar to 2020, all species collected in Stevens Creek in 2021 were native to the system and included the following: three-spined stickleback (*Gasterosteus aculeatus*), Southern Coastal California (SCC) roach (*Hesperoleucus venustus subditus*), Sacramento sucker (*Catostomus occidentalis*), and *O. mykiss*. Only 28 fish total were captured, four of which were *O. mykiss*. The majority of fish captured were Sacramento sucker (43%), followed by SCC roach (36%), *O. mykiss* (14%), and three-spined stickleback (7%).

Juvenile *O. mykiss* were observed at two of the four sampling sites (SC005 and SC BONUS). Only four juvenile *O. mykiss* (0.03/m) were captured throughout the sampling effort; a marked decline from the 0.20 *O. mykiss*/m captured during the 2020 sampling event. All *O. mykiss* captured were ≥65 mm (the minimum size required to receive a passive integrated transponder tag), and as such each individual was injected with a tag so that their movement could be monitored. Fork-lengths of sampled individuals ranged from 95 to 207 mm. While successful summer rearing occurred and multiple age classes were present in 2020, the size range collected in 2021 indicates *O. mykiss* production and/or survival of juvenile *O. mykiss* in 2021 was very low.

Due to the limited amount of data collected thus far, in addition to extreme drought conditions in water year 2021, it is difficult to assess any trends in juvenile *O. mykiss* abundance, distribution, or densities in Stevens Creek at this time. However, as more data becomes available in the following years a better understanding of *O. mykiss* populations and species composition in Stevens Creek will develop.

Contents

Executive Summary i

1. Introduction 1

2. Methods 2

2.1 Station Selection 2

Habitat Typing 2

2.2 Sampling Methods 5

Electrofishing 5

Fish Processing 5

2.3 Data Analysis 7

3. Results and Discussion 7

Habitat and Fish Sampling Data by Site 7

SC004 8

SC005 9

SC006 10

SC BONUS 12

Abundance and Composition 13

O. mykiss Distribution 16

O. mykiss Lengths 17

4. Conclusion 17

5. References 22

Tables

Table 1. Habitat type classifications (Ode 2007). 4
Table 2. Ocular estimate scale (Ode 2007). 4
Table 3. Substrate classes (Ode 2007). 4
Table 4. SC004 water quality data and ocular estimates of habitat complexity. 8
Table 5. Number of fish captured and population estimates at SC004. 9
Table 6. SC005 water quality data and ocular estimates of habitat complexity. 10
Table 7. Number of fish captured and population estimates at station SC005. 10
Table 8. SC006 water quality data and ocular estimates of habitat complexity. 11
Table 9. Number of fish captured and population estimates at station SC006. 11
Table 10. SC BONUS water quality data and ocular estimates of habitat complexity. 12
Table 11. Number of fish captured and population estimates at station SC007. 13
Table 12. Total fish per meter observed in Stevens Creek and change from 2020 to 2021. 14

Figures

Figure 1. Stevens Creek juvenile rearing monitoring stations. Red dots indicate stations that were not sampled in 2021. 3
Figure 2. Photos of Station SC004 looking upstream (left) and downstream (right). 8
Figure 3. Photos of Station SC005 looking upstream (left) and downstream (right). 9
Figure 4. Photos of Station SC006 looking upstream (left) and downstream (right). 11
Figure 5. Photos of SC BONUS looking upstream (left) and downstream (right). 12
Figure 6. Fish species composition in Stevens Creek in 2020 (n = 240, total sample area length = 240 m). 15
Figure 7. Fish species composition in Stevens Creek in 2021 (n = 28, total sample area length = 158 m). 15
Figure 8. *O. mykiss* capture by sites sampled in 2020 (n = 47) and 2021 (n = 4), from upstream to downstream. 16

Appendix

Appendix A: 2021 Stevens Creek Stream Temperature Monitoring

Appendix B: 2021 Stevens Creek Central California Coast Steelhead (Oncorhynchus mykiss) Fish Condition Analysis

1. Introduction

Stevens Creek originates at 2,300 feet elevation in the Monte Bello Open Space Preserve in the Santa Cruz Mountains. It flows in a southeast direction primarily through open space for approximately 13 km before reaching Stevens Creek Reservoir. The western portion of the watershed where Stevens Creek originates remains relatively free of anthropogenic disturbance. Below the dam, Stevens Creek continues north for approximately 20 km and empties into the San Francisco Bay through Whisman Slough near Stevens Creek Shoreline Nature Area Preserve. The eastern and southern portions of Stevens Creek flow across the Santa Clara County Valley floor, traversing primarily urbanized areas with scattered patches of undeveloped park land. Stevens Creek drains a watershed of roughly 75 square kilometers.

Stevens Creek supports federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment and is critical habitat from the creek's confluence with San Francisco Bay to Stevens Creek Reservoir (DPS, 70 FR 52570, September 2005). In an attempt to better understand *O. mykiss* populations within this system, Valley Water biologists performed index reach monitoring for juvenile *O. mykiss* rearing on Stevens Creek using multi-pass depletion backpack electrofishing. The goal of the sampling was to document the abundance, distribution, and densities of *O. mykiss* in the system, as well as the composition of other fish species. A tracking study was implemented for juvenile *O. mykiss* using passive integrated transponder (PIT) tags to document movement in the system, and genetic information on *O. mykiss* was collected. These efforts will help inform the success of the Valley Water Fish and Aquatic Habitat Collaborative Effort (FAHCE), which seeks to improve aquatic spawning and rearing habitat as well as fish passage in the Guadalupe River, Coyote Creek, and Stevens Creek.

2. Methods

2.1 Station Selection

The study area for Stevens Creek was defined as the extent between Homestead Road and the base of the Stevens Creek Reservoir Dam. This area was chosen as it typically has perennial flow in most years and is the area where juvenile *O. mykiss* rearing is expected to occur. In 2020, six juvenile *O. mykiss* rearing sampling sites were selected on Stevens Creek (SC001 – SC006). Stations were selected using stratified random sampling as well as by selecting areas of interest. Details associated with site selection can be found in the 2020 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Stevens Creek report (Valley Water 2021). Because half of these sites were dry in 2021, only three were re-sampled and a new station (SC BONUS) was added, for a total of four stations sampled in Stevens Creek during November 2021. SC BONUS was selected for this monitoring season to increase the number of sites sampled. After spot-checking the creek, it was determined that this location provided the most easily accessible sampling site with suitable *O. mykiss* habitat. The target length for each sampling station was 40 meters; however, due environmental constraints preventing block net installation in 2021 one site (SC BONUS) was 38 meters in length.

The locations of the 2021 Stevens Creek sampling station can be seen in Figure 1. Valley Water also initiated stream temperature monitoring within the study area and in other sections of the anadromous portion of Stevens Creek in 2020. Details regarding stream temperature monitoring are provided in Appendix A.

Habitat Typing

Habitat typing was ultimately left to the discretion of the principal investigator, with Ode (2007) serving as a guideline. Each sampling station was habitat-typed using the following habitat units: cascade, fall, rapid, riffle, run, step-run, glide, or pool (Table 1). Average wetted width and depth was visually estimated after walking the entire reach. The presence of any anthropogenic influences (e.g., bridge, dam, etc.) was noted. Prior to the start of sampling, ambient weather conditions were recorded and water quality

data (dissolved oxygen, conductivity, and temperature) were collected at the upstream end of each monitoring station.

The percent of the sampling reach supporting macrophytes/emergent vegetation, boulders, woody debris, undercut banks, overhanging vegetation, root wads, or artificial structures was recorded based on ocular estimates. Percentages were binned and each habitat feature was recorded on a 0 to 4 point scale (Table 2). Primary and secondary substrate types were determined based upon ocular estimates (Table 3).



Figure 1. Stevens Creek juvenile rearing monitoring stations. Red dots indicate stations that were not sampled in 2021.

Table 1. Habitat type classifications (Ode 2007).

Habitat Type	Description
Cascades	Short, high gradient drop in streambed elevation often accompanied by boulders and considerable turbulence.
Falls	High gradient drop in elevation of the streambed associated with an abrupt change in the bedrock.
Rapids	Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles.
Riffles	Shallow sections where the water flows over coarse streambed particles that create mild to moderate surface turbulence.
Step-Run	A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope.
Runs	Sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool.
Glides	A section of stream with little or no turbulence, but faster velocity than pools.
Pool	A reach of stream that is characterized by deep, low-velocity water and a smooth surface.

Table 2. Ocular estimate scale (Ode 2007).

Scale	0	1	2	3	4
Percent Coverage	0%	<10%	10-40%	40-75%	>75%
Descriptor	Absent	Sparse	Moderate	Heavy	Very Heavy

Table 3. Substrate classes (Ode 2007).

Particle Size	Size Category
Boulder	> 250 mm
Cobble	64-250 mm
Gravel	2.0-64 mm
Sand	<2.0 mm (gritty texture)
Silt/Clay	Not gritty
Bedrock	No individual particles

2.2 Sampling Methods

Multi-pass depletion backpack electrofishing (Johnson et al. 2007) was conducted at each station. These methods allowed for consistency with other juvenile rearing monitoring efforts within the area, the extrapolation of population estimates, and the sampling of a variety of habitat types. Block nets were deployed during sampling at the upstream and downstream end of each reach to prevent fish immigration and emigration from the rest of the channel. Block nets were secured with rebar to hold the nets in place and spreaders were used to keep the tops above water. Large rocks were used to add extra security to the lead line and keep the bottom of the net flush with the channel bed.

Electrofishing

Smith-Root LR24 Backpack Electrofishing Units were used at all sampling sites. Electrofishing was conducted from downstream to upstream throughout each reach. Only one LR24 backpack electrofisher was used during each sampling event as the channel width never exceeded 3 m (Johnson et. al 2007). The electrofisher operator was flanked by two netters. Verbal communication and spatial awareness were used to ensure the entire width of the stream was covered. Fish captured were held in dark colored 5-gallon buckets or live cars during each electrofishing pass and held in aerated 5-gallon buckets during processing (described below). After each pass, all fish were transferred to a live car outside of the sampling reach and outside of the field of current from the electrofisher in an area with flow and adequate shade from the time processing ended until the sampling event was complete to allow fish time to recover and to prevent processed fish from re-entering the sampling reach. All fish were released back to the stream sampling reach after the final pass.

Fish Processing

All *O. mykiss* were weighed and measured regardless of number caught in a pass. Lengths were recorded to the nearest millimeter at the fork of the tail (fork-length). Weights were recorded for *O. mykiss* to the nearest tenth of a gram using an Ohaus

NVT22001 scale. For all other fish species, after each pass with the electrofisher up to 30 individuals of each species were measured (fork-length), and all other individuals of that species were tallied for a total number.

Carbon dioxide (CO_2) was administered to all *O. mykiss* individuals via Alka-Seltzer Gold tablets placed in a bucket with onsite stream water in doses sufficient to induce light narcosis (1 tablet per 2.5 liters of stream water). Each individual was exposed to the anesthesia for no more than five minutes. *O. mykiss* were observed for listing, and upon listing were removed from the anesthetizing solution, scanned to determine if a PIT tag was present, weighed, measured, tail-clipped for a genetic sample, and PIT tagged if large enough (≥65 mm fork-length) and not previously tagged. After all procedures were completed, fish were immediately returned to a dark-colored 5-gallon bucket filled with aerated stream water to recover before being transferred to an in-channel live car for full recovery before being released back into the channel at the end of the sampling event.

Caudal fin clips were taken from all *O. mykiss* for genetic analysis. Clips were 1-2 mm^2. Medical grade scissors were used for cutting and they were sterilized between each use with an alcohol dilution with a final concentration of at least 60-80% isopropyl. Tissue samples were placed in sterile chromatography paper and then placed in a labeled envelope denoting the field specimen number, species, stream, sample reach ID, date, and fork-length. Collected tissues will be sent to the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center for analysis once an adequate sample size has been obtained.

All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 1999) by staff trained in the procedure. All *O. mykiss* of 65 mm in fork-length or greater, which had not been previously tagged, received a PIT tag. Biomark single-use, preloaded needles were used in the tagging process. *O. mykiss* greater than or equal to 65 mm to 149 mm fork-length received 12 mm half-duplex PIT tags. *O. mykiss* 150 mm fork-length or greater received 23 mm tags. The permits allow for fish

greater than 100 mm to be tagged with 23 mm tags, but to be conservative of the fishes' welfare Valley Water increased the minimum size for a 23 mm tag to 150 mm.

2.3 Data Analysis

MicroFish 3.0 was used to calculate population estimates for each station using a maximum likelihood iterative process (MLIP); the associated standard errors and 95% confidence intervals (CI) are reported in the following section. This method uses the number of fish captured (n) and the difference in capture between each subsequent electrofishing pass (i.e., depletion rate) to calculate an estimate of fish likely to have been present but not captured, thus generating a population estimate (N) for each station. Population estimates are restricted to the sampled areas and are only an index of the overall population. If the number of a particular species was too low (i.e., only one fish was captured) or all individuals of a particular species were captured on the first pass (with no individuals of that species captured on subsequent passes), then a MLIP population estimate could not be produced. If the lower confidence interval was less than the total catch it was set equal to the total catch, as it is certain at least that many fish were present in the sampling reach. These calculations assume no emigration or immigration occurred throughout the duration of sampling, shocking efficiency did not change between passes, staff did not become more efficient at using the equipment, and fish did not learn to avoid the electrical field between passes.

3. Results and Discussion

Habitat and Fish Sampling Data by Site

Sampling occurred at four stations in Stevens Creek on November 8, 2021. The weather was sunny and clear with no precipitation. Flows at the ALERT 5044 stream gage on Stevens Creek below Stevens Creek Reservoir remained at approximately 0.7 cubic feet per second (cfs) throughout the day.

SC004

SC004 was located at one of Valley Water's Stream Maintenance Program's (SMP) restoration sites, at the McClellan Ranch Preserve. SMP installed woody debris and gravel in the river channel and the site had a robust riparian corridor. The monitoring station was 40 m in length with an average wetted width of 2.25 m and an average depth of 0.3 m (Figure 2). There were three habitat types present: riffle, run, and pool. The riffle made up the majority of habitat at 35%, with the run and pools each comprising 32.5%. The primary substrate was cobble and the secondary substrate was silt. Water quality and habitat complexity are summarized in Table 4.



Figure 2. Photos of Station SC004 looking upstream (left) and downstream (right).

Table 4. SC004 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/l)**	**Turbidity (NTU)**			
623	11.35	9.67	22.9			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
2	1	2	0	2	2	1

Fish captured and associated population estimates are summarized in Table 5. Only three individual fish of two different species were captured at this site: SCC roach (*Hesperoleucus venustus subditus*) and three-spined stickleback (*Gasterosteus aculeatus*). The MLIP indicates that the number of fish captured likely represented the number of fish present in the reach at the time sampling occurred.

Table 5. Number of fish captured and population estimates at SC004.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	1	-	-	-
Three-spined stickleback	Yes	2	2	0.38	2-7

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

SC005

Station SC005 was located in Stevens Creek County Park, and as such surrounded by rural park land. A dense riparian corridor was present with thick canopy cover. The monitoring station was 40 m in length with an average wetted width of 2.5 m and an average depth of 0.15 m (Figure 3). Three habitat types were present: riffle, run, and pool. The riffle made up 37.5% of the habitat, the pool made up 32.5%, and the run made up 30%. The primary substrate was cobble and the secondary substrate was silt. Water quality and habitat complexity are summarized in Table 6.



Figure 3. Photos of Station SC005 looking upstream (left) and downstream (right).

Table 6. SC005 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/l)**	**Turbidity[1] (NTU)**			
683	11.52	10.20	—			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
0	1	1	1	3	2	1

[1] Turbidity was not recorded at this site.

Fish captured and associated population estimates are summarized in Table 7. Three fish species were captured at this site: SCC roach*, O. mykiss*, and Sacramento sucker (*Catostomus occidentalis*). The MLIP indicates that the number of SCC roach present in the stream at the time of sampling was likely higher than observed.

Table 7. Number of fish captured and population estimates at station SC005.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	5	6	3.57	5-15
O. mykiss	Yes	3	3	0.71	3-6
Sacramento sucker	Yes	4	4	0.97	4-7

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

SC006

Station SC006 was the most upstream site sampled. It was located within Stevens Creek County Park, just downstream of the Stevens Creek Reservoir. It had a dense riparian corridor and was heavily shaded. The monitoring station was 40 m in length, had an average wetted width of 2.5 m, and an average depth of 0.25 m (Figure 4). Three habitat types were present: pool, riffle, and run. The reach was made up of 45% pool habitat, 30% riffle, and 25% run. The primary substrate was cobble and the secondary substrate was silt. Water quality and habitat complexity are summarized in Table 8.



Figure 4. Photos of Station SC006 looking upstream (left) and downstream (right).

Table 8. SC006 water quality data and ocular estimates of habitat complexity.

Water Quality						
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/l)**	**Turbidity (NTU)**			
693	12.79	8.62	94.5			
Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
0	2	1	2	3	2	0

Fish captured and associated population estimates are summarized in Table 9. Two fish species were captured at this site: SCC roach and Sacramento sucker. The most abundant species caught was Sacramento sucker. The MLIP indicates that the number of fish captured likely represented the number of fish present in the reach at the time sampling occurred.

Table 9. Number of fish captured and population estimates at station SC006.

Species	Native	n	N	SE	95% CI
SCC roach	Yes	4	4	0.21	4-5
Sacramento sucker	Yes	8	8	0.51	8-9

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

SC BONUS

SC BONUS was located near the visitor center within Stevens Creek County Park, downstream of SC006 and upstream of SC005. It had a robust riparian corridor. The monitoring station was 38 m in length, had an average wetted width of 1.5 m, and an average depth of 0.2 m (Figure 5). Three habitat types were present: riffle, pool, and run. The reach was made up of 50% riffle habitat, 39.5% pool, and 10.5% run. The primary substrate was cobble and the secondary substrate was silt. Water quality and habitat complexity are summarized in Table 10.



Figure 5. Photos of SC BONUS looking upstream (left) and downstream (right).

Table 10. SC BONUS water quality data and ocular estimates of habitat complexity.

Water Quality			
Conductivity (µS/cm)	**Temperature (°C)**	**Dissolved Oxygen (mg/l)**	**Turbidity[1] (NTU)**
669	13.22	9.87	—

Habitat Complexity Scoring						
Macrophytes/Emergent Vegetation	**Boulders**	**Woody Debris**	**Undercut Banks**	**Overhanging Vegetation**	**Roots**	**Artificial Structures**
1	1	1	1	2	1	1

[1] Turbidity was not recorded at this site.

One *O. mykiss* and no other fish of any species were captured at this site. Fish captured and associated population estimates are summarized in Table 11. The MLIP indicates that the number of *O. mykiss* captured likely represented the number present in the reach at the time sampling occurred.

Table 11. Number of fish captured and population estimates at station SC007.

Species	Native	n	N	SE	95% CI
O. mykiss	Yes	1	-	-	-

n = total number captured, N = calculated population estimate, SE = standard error, CI = confidence interval

Abundance and Composition

Overall fish capture in Stevens Creek was lower in water year (WY) 2021 than WY 2020. The mean monthly discharge at gage 5044 below Stevens Creek Reservoir was approximately 3.0 cubic feet per second (cfs) for the months of June, July, and August 2020. In 2021, the average cfs was approximately 0.7 cfs for those same months. When sampling occurred in October 2020, a total of 240 stream meters were sampled and 240 fish of four different species were captured (total 1 fish/m) and the monthly mean discharge was 3.1 cfs. In November 2021, total stream meters sampled were lower due to drought conditions which resulted in a monthly mean discharge of 0.6 cfs. Within 158 stream meters sampled, only 28 fish of four different species were captured (total 0.18 fish/m). In both years, only native species were observed in Stevens Creek, and the same four species were observed in each year: three-spined stickleback, SCC roach, Sacramento sucker, and *O. mykiss*.

The number of fish per meter observed declined for every species between WY 2020 and 2021 (Table 12). The greatest decline was in SCC roach, followed by three-spined stickleback. In 2020, SCC roach, *O. mykiss*, and Sacramento sucker were all captured at every site where sampling occurred. Capture rates were greatest for all of these species in the middle sampling reaches (SC002 to SC004). In 2021, there was no species that was observed at every site. SC001 to SC003 were not able to be sampled,

and capture rates were greatest at the middle and most upstream sites sampled (SC005 and SC006). *O. mykiss* capture declined from 0.20/m (n=47) in 2020 to 0.03/m (n=4) in 2021. In 2020, the MLIP indicated that the density of *O. mykiss* on Stevens Creek was likely higher than what was observed during the sampling effort (0.3/m, N=73). In 2021, the MLIP indicates that the density of *O. mykiss* was likely not higher than what was observed during the sampling effort. In 2021, 0.08 and 0.03 *O. mykiss*/m were captured at SC005 and SC BONUS, respectively.

Table 12. Total fish per meter observed in Stevens Creek and change from 2020 to 2021.

Species	2020	2021	Change
SCC roach	0.33	0.06	- 0.27
O. mykiss	0.20	0.03	- 0.17
Sacramento sucker	0.25	0.08	- 0.17
Three-spined stickleback	0.23	0.01	- 0.22

In 2020, SCC roach made up the largest percentage of total catch (33%); however, proportions were evenly spread among all species observed. In 2021, Sacramento sucker made up the majority of the catch (43%). SCC roach were the second most observed species, followed by *O. mykiss*. Proportion of fish captured by species in 2020 and 2021 is illustrated in Figures 6 and 7, respectively.

In both years in which sampling occurred on Stevens Creek, three-spined stickleback were caught in the more downstream sampling reaches only (SC001, SC002, SC003, and SC004 in 2020; and only SC004 in 2021). Due to the drought, the most downstream monitoring site able to be sampled in 2021 was SC004, which was the upstream extent of where stickleback were observed in 2020.

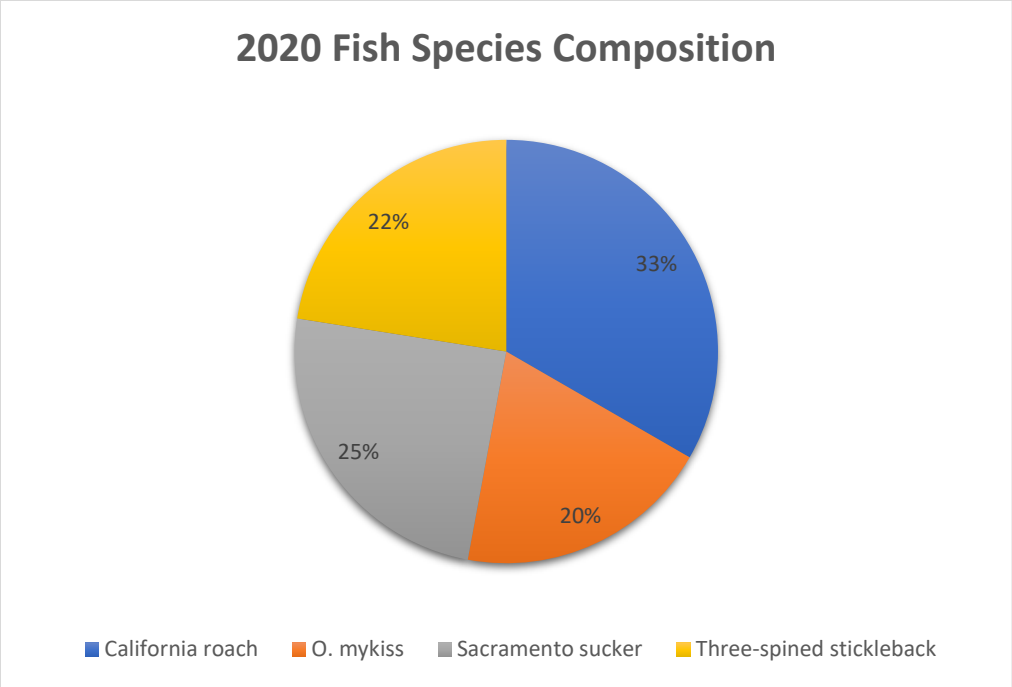


Figure 6. Fish species composition in Stevens Creek in 2020 (n = 240, total sample area length = 240 m).

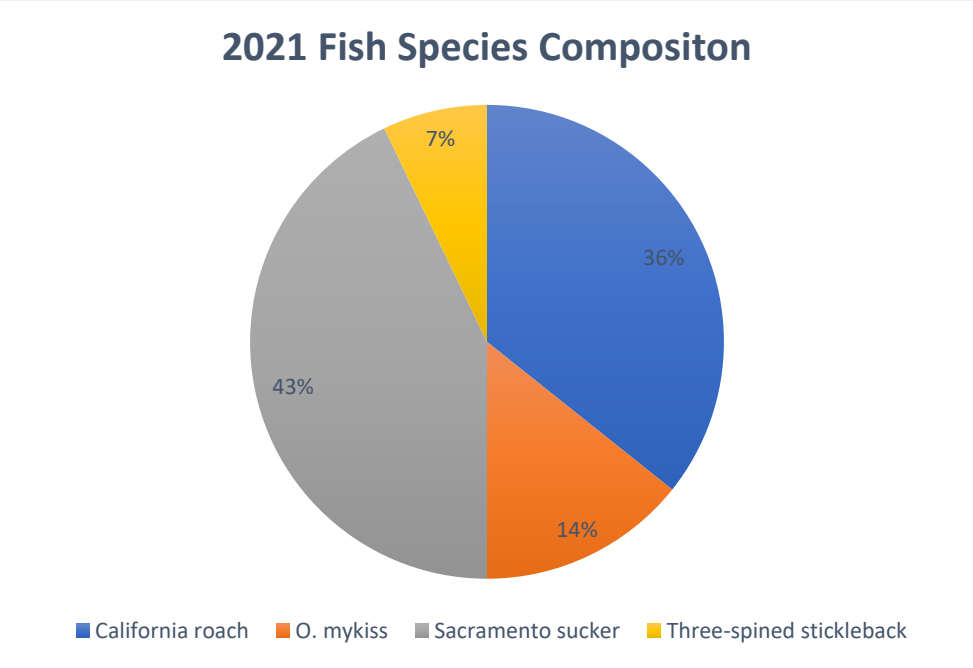


Figure 7. Fish species composition in Stevens Creek in 2021 (n = 28, total sample area length = 158 m).

O. mykiss Distribution

O. mykiss were captured at SC005 in both years. In 2020, *O. mykiss* were captured at each sampling site, with the number captured being lowest at the most downstream site (SC001). The greatest number of *O. mykiss* were captured at SC002, and numbers declined as sampling moved upstream (Figure 8). In 2021, *O. mykiss* were only captured at two sites (SC005 and SC BONUS). Numbers declined as sampling moved from upstream to downstream; however, the sample size was low, so data should be interpreted with caution (Figure 8).

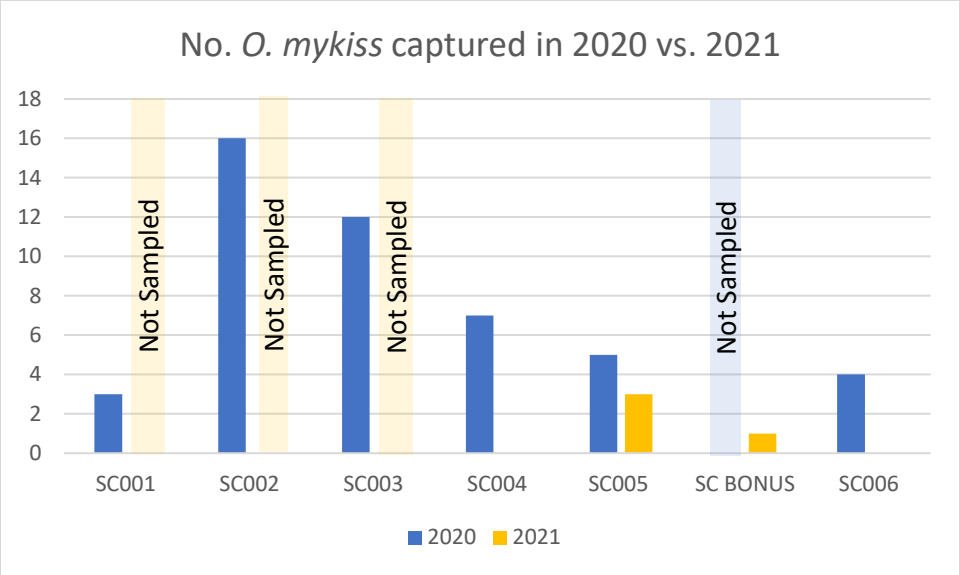


Figure 8. *O. mykiss* capture by sites sampled in 2020 (n = 47) and 2021 (n = 4), from upstream to downstream.

O. mykiss Lengths

Four *O. mykiss* were captured in 2021 ranging from 95 to 207 mm. At SC005, the fork-length measurements were as follows: 95, 198, 207 mm. One *O. mykiss* was captured at SC BONUS measuring 98 mm. One of the four *O. mykiss* captured on November 8, 2021 was an individual that was previously tagged. That fish was originally captured and tagged on October 28, 2020. The fish was captured at SC005 in both sampling events. In 2020, the individual measured 122 mm fork-length and weighed 21.0 g. In 2021, that same individual measured 207 mm and weighed 114 g, meaning it grew 85 mm and gained 93 g in one year. Growth rates of juvenile *O. mykiss* vary depending on temperature, food availability, stream flow, and competition. According to Moyle (2002), in small streams with low summer flows, such as Stevens Creek, young-of-the-year (YOY) steelhead measure 50 to 90 mm, and fish at the end of their second year measure 100 to 160 mm. Smith and Leicester (2016) aged 32 fish from Guadalupe Creek and found that young-of-the-year *O. mykiss* ranged from 85 to 114 mm, fish in their first year ranged from 110 to 199, and fish in their second year ranged from 170 to 224 mm. This is a faster growth rate than predicted by Moyle (2002), but this is expected in warmer, more productive systems.

Applying the growth rates proposed Smith and Leicester (2016), fish sampled were likely YOY and 2 years old (two in each age class). Growth rates observed in the Stevens Creek recapture are consistent with the rates observed by Smith and Leicester (2016), indicating that individual would have been YOY in 2019, one year old in 2020, and two years old in 2021.

4. Conclusion

While this is only the second year of juvenile rearing monitoring in Stevens Creek, numbers of fish of all species captured declined from the previous year. All fish captured were native; no non-native species were observed during sampling efforts in 2020 or 2021. Only four *O. mykiss* (0.03/m), two of which were YOY age class, were captured.

While there was no evidence of black spot disease or other maladies and they were overall in healthy condition, it appears that production and/or survival of juvenile *O. mykiss* in 2021 was very low. Because there was successful juvenile rearing on Stevens Creek in 2020 and multiple age classes were present at that time, it can be assumed that conditions in Stevens Creek are suitable to support juvenile *O. mykiss* rearing. Physical habitat features, such as overhanging vegetation and root wads, were present at all sites sampled and water quality characteristics at the time of sampling were suitable to support *O. mykiss.*

According to the National Oceanic and Atmospheric Administration's (NOAA's) National Integrated Drought Information System (NIDIS), Santa Clara County is currently in a drought. The majority of the county, including Stevens Creek Watershed, is categorized as "extreme drought," meaning that water supply is inadequate for agriculture, wildlife, and urban needs and reservoirs are extremely low. They categorize 2021 as the 16th driest year to date over the past 127 years.

Drought can result in reduced water quality and streamflow; this can reduce connectivity to suitable habitat, limiting movement and overall habitat availability. Drought conditions can have immediate effects on fish and invertebrate species' abundance, growth, survival, location in the watershed or migration capabilities. Maintaining connectivity between freshwater and marine habitats is essential to the anadromous life form of *O. mykiss*. Effects to aquatic ecosystems may be short-term or long-lasting, depending on the severity and duration of the drought.

Because this was only the second year of surveys conducted by Valley Water on Stevens Creek, and because WY 2021 experienced drought conditions, it is difficult to assess any trends at this time. Stream meters sampled were reduced in 2021 due to drought conditions, and the drought likely affected abundance and distribution of all fish species in Stevens Creek. As sampling efforts continue in the following years and more data becomes available, a better understanding of the *O. mykiss* population in Stevens Creek will develop.

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Appendix A

2020 – 2021 Stevens Creek Stream Temperature Monitoring

2020-2021

Stevens Creek
Stream Temperature Monitoring

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January 2022

Contents

Introduction 1
Methods 1
Monitoring Stations 1
Temperature Loggers 3
Logger Deployment 4
Data Download and Analysis 4
Results 5
STEV1 5
STEV3 6
STEV4 7
STEV5 8
STEV6 9
Discussion 10
References 11

Figures

Figure 1. Stevens Creek stream temperature monitoring stations. 2
Figure 2. Onset HOBO® MX2203 Tidbit temperature logger. 3
Figure 3. Galvanized steel pipe housing for temperature loggers. 4
Figure 4. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV1 6
Figure 5. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV3 7
Figure 6. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV4 8
Figure 7. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV5 9
Figure 8. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV6 10

Introduction

Stevens Creek consists of approximately 32 kilometers (20 miles) of channel and originates in the Monte Bello Open Space Preserve in the Santa Cruz Mountains. The western portion of the watershed where Stevens Creek originates remains relatively free of anthropogenic disturbance. The creek flows southeasterly through the Stevens Creek County Park before entering Stevens Creek Reservoir, then continues north and empties into the San Francisco Bay at the Whisman Slough next to Mountain View's Shoreline Park. The eastern and northern potions of Stevens Creek flow across the Santa Clara County Valley floor, traversing mainly urbanized areas with patches of undeveloped park land. Stevens Creek drains a watershed of roughly 75 square kilometers (29 square miles).

Stevens Creek supports the federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*, *O. mykiss*) Distinct Population Segment (DPS) and is designated critical habitat from the creek's confluence with the San Francisco Bay to Stevens Creek Reservoir (70 FR 52570, September 2005).

Stream temperature is an important factor affecting the abundance and distribution of *O. mykiss.* To provide continuous monitoring of temperature conditions and help assess *O. mykiss* habitat suitability within Stevens Creek, Valley Water initiated stream temperature monitoring throughout the designated habitat portion of the system in 2020. This report summarizes the data for Water Year 2021 (October 1, 2020 – September 30, 2021) and is the second year of temperature monitoring in Stevens Creek.

Methods

Monitoring Stations

To provide spatial coverage of the anadromous portion of Stevens Creek (the same portion that is designated critical habitat for *O. mykiss*), stream temperatures were monitored at six stations between the creek's confluence with the San Francisco Bay and Stevens Creek Reservoir (Figure 1). Stations STEV6, STEV5, and STEV4 are within the Stevens Creek cold water management zone and typically stay perennially wetted throughout the year. This area is where juvenile *O. mykiss* rearing is expected to occur. Stations STEV3, STEV2, and STEV1 experience variable flow and are outside of the area of influence of cold water release from

Stevens Creek Reservoir. Station locations are subject to change and additional stations may be established as monitoring efforts continue and management objectives are modified.

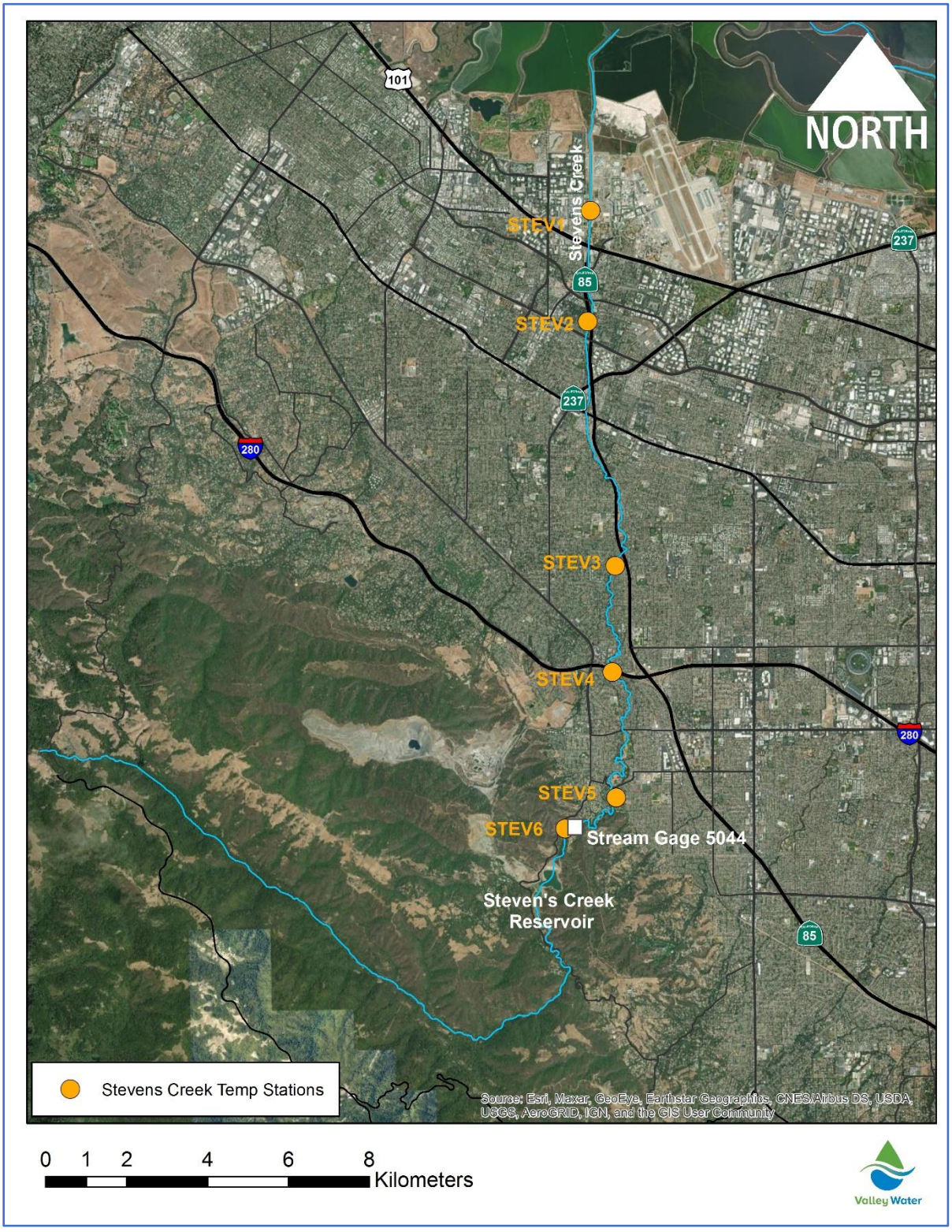


Figure 1. Stevens Creek stream temperature monitoring stations.

Temperature Loggers

Temperatures were recorded using Bluetooth-capable Onset HOBO® MX2203 Tidbit Temperature Loggers (herein referred to as logger(s)) (Figure 2). The loggers measured 4.45 x 7.32 x 3.58 cm, weighed 36.2 g, and had an accuracy of ±0.25°C with a resolution of 0.01°C. Using the Onset HOBO® mobile application from a smartphone, each logger was programmed to collect data at a 1-hour sampling rate and to start recording on the hour interval (e.g., 1:00PM, 2:00PM) following the deployment time.

Each logger was housed in an 11.5 cm x 4.3 cm galvanized steel pipe fitted with a cap at each end (Figure 3). The pipe had four 1.5 cm-diameter holes on the sides and a single hole on each of the caps to allow water to flow through the housing. In addition to providing protection and to shield the loggers from direct sunlight, the housing was also used to weigh down the logger, which helped ensure that it maintained contact with the streambed and thus remained submerged.



Figure 2. Onset HOBO® MX2203 Tidbit temperature logger.



Figure 3. Galvanized steel pipe housing for temperature loggers.

Logger Deployment

Loggers are deployed year-round in Stevens Creek. The housings (with logger inside) were attached using wire clips to a steel cable that was anchored to a stake or natural feature (e.g., tree trunk, root) along the bank of the channel. Loggers were placed in pools whenever possible to help ensure that they would stay submerged during summer low flows. One logger was deployed at each monitoring station.

Station STEV2 was dry for most of Water Year 2021 and there is very little useable data for the station, therefore, STEV2 is not included in the following sections.

Data Download and Analysis

The temperature data was downloaded in the field onto a smartphone using the Onset HOBO® mobile application. Once downloaded, data was transferred to the internal Valley Water network and visually inspected for any erroneous temperature readings that may have resulted from either logger malfunction or the logger not being submerged in water. The loggers also had a water detection capability that recorded when the logger was “in” versus “out” of the water. This function was useful during the initial data evaluation to help differentiate between water temperature and air temperature recordings. Anomalous data was clipped from the dataset before further analysis.

Temperature data was analyzed for the Water Year 2021 (October 1, 2020-September 30, 2021). For each monitoring station, daily averages, minimums, and maximums were calculated, as well as the 7-day moving average to smooth out daily fluctuations and highlight trends. The 7-day moving average was calculated for each day as the average stream temperature

observed for the last 7 days (that day plus the 6 consecutive days prior). Maximum weekly average temperature (MWAT) was also determined for each station and computed as the maximum value of the 7-day moving average of daily mean stream temperature for the monitoring period.

The release rate from Stevens Creek Reservoir into Stevens Creek ranged from 0.5 and 5.3 cubic feet per second (cfs) during Water Year 2021 (retrieved from the Valley Water Surface Water Data Portal, see Figure 1 for stream gage location). This information was considered when interpreting the results of the temperature data analysis.

Results

STEV1

Station STEV1 is the most downstream monitoring station located approximately 3.2 km upstream of San Francisco Bay and 0.6 km downstream of Highway 101 in the city of Mountain View. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, are shown in Figure 4. In Water Year 2021, stream temperatures ranged from 7.4 to 25.1°C with an average daily fluctuation of 3.7°C. The MWAT for station STEV1 during the monitoring period was 21.0°C.

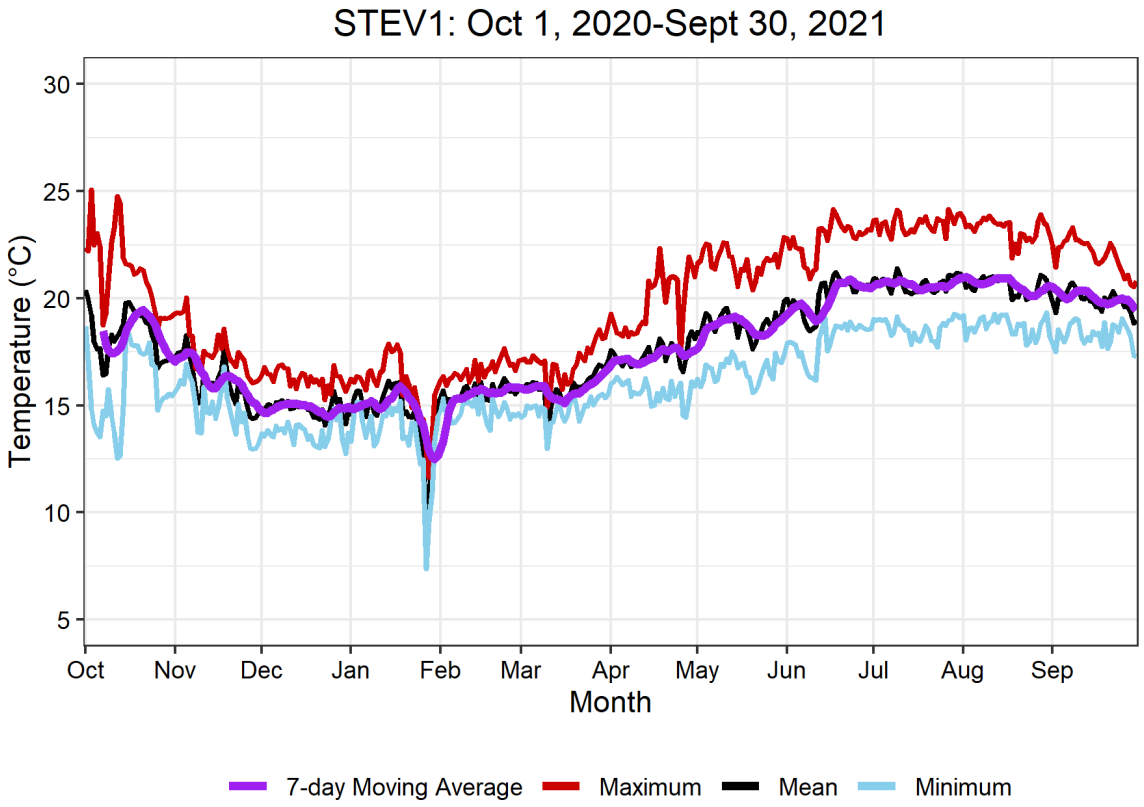


Figure 4. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV1.

STEV3

Station STEV3 is located upstream of STEV2 at Fremont Avenue in Sunnyvale. Temperature data for the logger is only available for the station up to February 19, 2021 due to drought-induced dry back. The logger was also out of the water for two weeks in January, presumably due to decreasing flows, before the site went completely dry. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, for this station are shown in Figure 5. Between October 1, 2020 and February 19, 2021, stream temperatures ranged from 5.9 to 20.7°C with an average daily fluctuation of 1.6°C. The MWAT for station STEV3 during the monitoring period was 18.5°C.

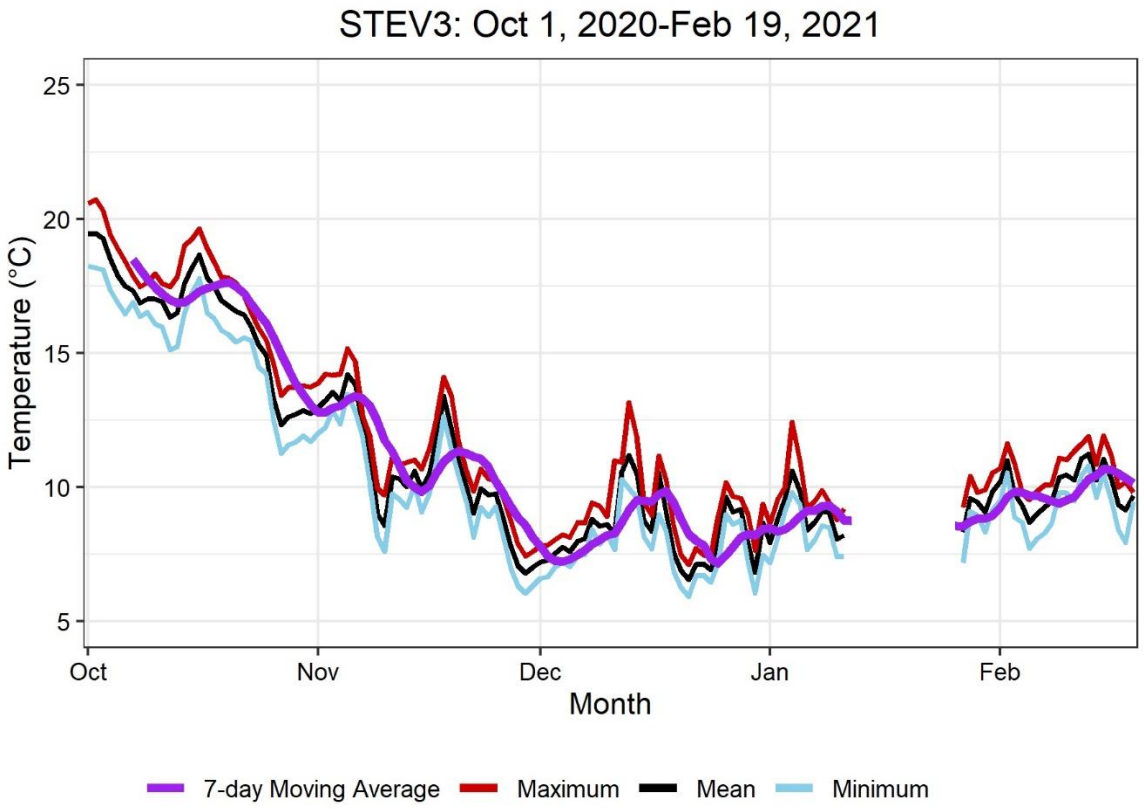


Figure 5. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV3.

STEV4

Station STEV4 is located upstream of STEV3 and just downstream of Highway 280 in Cupertino. The station is approximately 300 m downstream of *O. mykiss* juvenile rearing monitoring site SC001 (see Valley Water 2022a). Anomalously high, sporadic temperature readings were observed between January 15−27 and February 23−April 15, and as a result, data between these dates was clipped from the dataset and excluded from analysis. These erroneous readings were due to drought-induced low flow conditions at station STEV4. When the station was visited on April 15, the logger was barely submerged in water, thus exposed to air temperature fluctuations. Therefore, the logger was moved to a deeper pool roughly 6 m downstream of the original location where it would remain fully submerged. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, for this station are

shown in Figure 6. In Water Year 2021, stream temperatures ranged from 6.3 to 21.1°C with an average daily fluctuation of 1.7°C. The MWAT for station STEV4 was 18.8°C.

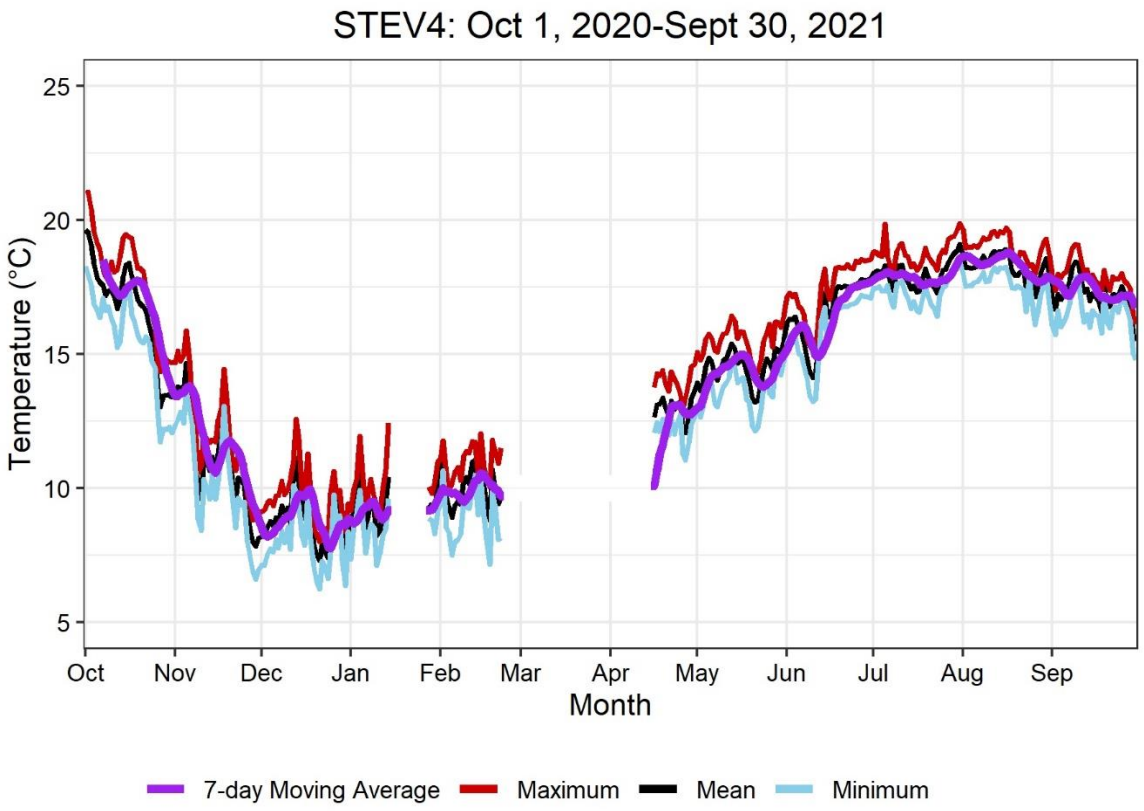


Figure 6. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV4.

STEV5

Station STEV5 is located upstream of STEV4 and just downstream of McClellan Road in Cupertino. The station is positioned within the *O. mykiss* juvenile rearing monitoring reach, SC004 (see Valley Water 2022a). Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, for this station are shown in Figure 7. In Water Year 2021, stream temperatures ranged from 6.3 to 23.4°C with an average daily fluctuation of 2.1°C. The MWAT for station STEV5 during the monitoring period was 19.2°C.

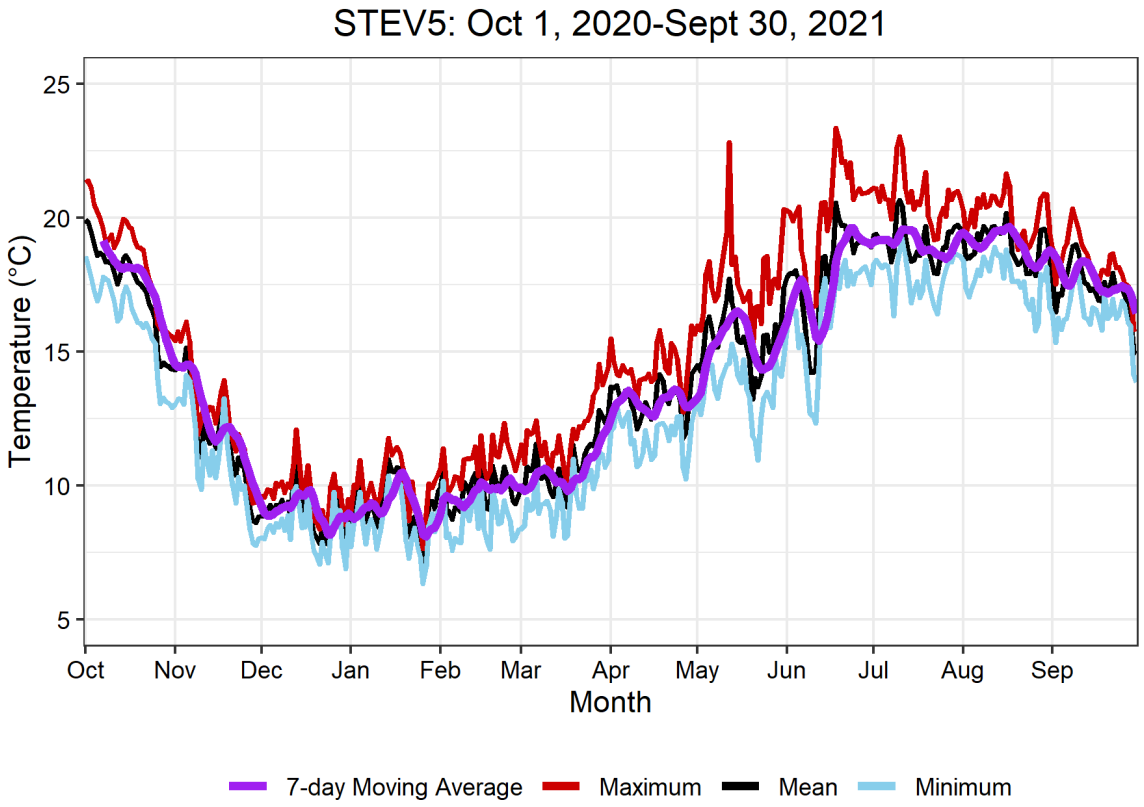


Figure 7. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV5.

STEV6

Station STEV6 is the most upstream monitoring station located approximately 0.6 km downstream of the Stevens Creek Reservoir outlet. The station is situated immediately downstream of 2021 *O. mykiss* juvenile rearing site SCBONUS (see Valley Water 2022a). Due to a malfunction with the temperature logger, data is only available for this station up to July 15, 2021. Daily mean, minimum, and maximum temperatures, along with the 7-day moving average, for this station are shown in Figure 8. Between October 1, 2020 and July 15, 2021, stream temperatures ranged from 7.7 to 22.3°C with an average daily fluctuation of 1.4°C. The MWAT for station STEV6 during the monitoring period was 20.8°C.

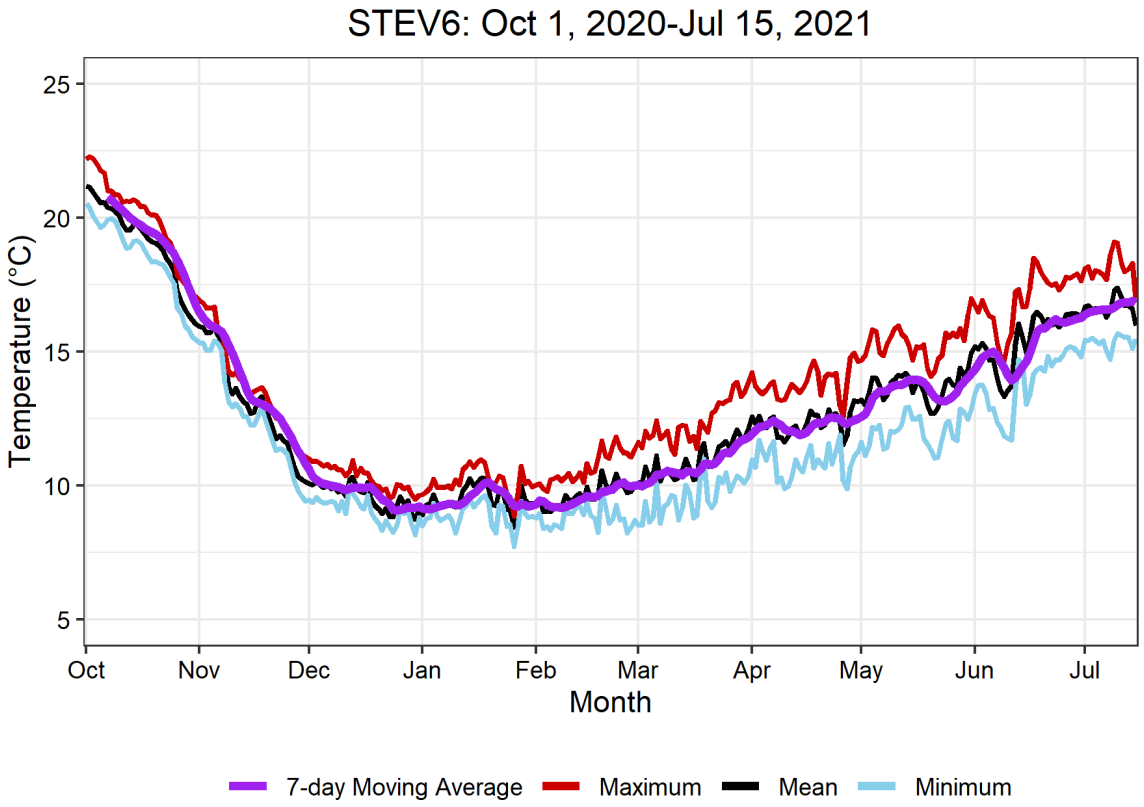


Figure 8. Daily mean, minimum, and maximum temperatures and 7-day moving average at monitoring station STEV6.

Discussion

All stations showed a similar trend where temperatures decreased until the end of January/beginning of February. For stations with available summer and fall data, temperatures increased until the middle of August, after which they decreased for the remainder of the Water Year. However, the rate of change differed slightly among stations. These temperature trends are typical for the region and have been observed in other Santa Clara County streams (Valley Water 2021, 2022b).

There were no apparent temperature patterns along the length of Stevens Creek as overall ranges and average daily fluctuations were similar among stations, though it should be noted that only STEV1 and STEV5 had complete datasets for Water Year 2021. Though normally, the upstream portions of streams within close proximity to bottom release reservoirs exhibit more

consistent and less variable temperatures than downstream locations. This is due to the thermal buffering caused by the reservoir pool. However, STEV6 (most upstream station) experienced similar daily temperature fluctuations to stations further downstream on Stevens Creek. The low reservoir level (and low flow releases) due to the extreme drought conditions of Water Year 2021 likely reduced the effects of the reservoir's thermal buffering.

Of note, station STEV1 displayed daily ranges that were greatest in the spring and summer months with large variations present between daily minimum and maximum temperatures. This pattern has also been observed at several temperature monitoring stations in the Guadalupe River Watershed (Valley Water 2021, 2022b), and therefore may be a normal pattern in the region during the warmer months. We will be able to form a more definitive conclusion as data continues to be collected over the next several years.

Stevens Creek supported two *O. mykiss* age classes and summer rearing was known to occur based on the results of Valley Water's juvenile rearing monitoring effort, though *O. mykiss* numbers were low (Valley Water 2022a). Despite these low numbers, all fish sampled were in healthy condition with high relative weights (Valley Water 2022a). Stevens Creek is thus capable of supporting the rearing and persistence of juvenile *O. mykiss,* including in years with low flow conditions such as this Water Year 2021. The continuation of stream temperature monitoring, in conjunction with juvenile rearing sampling and other fisheries monitoring efforts, will be useful towards furthering our understanding of *O. mykiss* in Stevens Creek and informing management objectives.

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Valley Water 2022b. 2020-2021 Guadalupe River Watershed Stream Temperature Monitoring.

Appendix B

2021 Stevens Creek Central California Coast Steelhead (*Oncorhynchus mykiss)* Fish Condition Analysis

2021 Stevens Creek Central California Coast Steelhead (*Oncorhynchus mykiss)* Fish Condition Analysis

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January 2022

Contents

Introduction 1
Background 1
Methods 3
Data Collection 3
Calculations 3
Relative Weight Target Range 4
Interannual Comparisons 5
Results 5
Discussion 10
References 15

Tables

Table 1. Summary statistics of Stevens Creek juvenile O. mykiss relative weights (W_r) per 25-mm length class. Means are presented as the value ± SD. Sample size = n. 7
Table 2. Summary statistics of juvenile O. mykiss population W_r for Stevens Creek in 2020 and 2021. Means are presented as the value ± SD. Sample size = n. 9
Table 3. BMI orders detected between Stevens Reservoir and Highway 280 in 2019 and 2020. 12

Figures

Figure 1. Boxplot (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of juvenile O. mykiss relative weights (W_r) of all individuals sampled in Stevens Creek (n = 4). 6
Figure 2. Relative weight (W_r) as a function of fork-length for juvenile O. mykiss sampled in Stevens Creek. Regression line in blue with confidence bands in gray. 7
Figure 3. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) representing Stevens Creek juvenile O. mykiss relative weights (W_r) per 25-mm length class. 8
Figure 4. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of relative weights (W_r) for juvenile O. mykiss by sampling site in Stevens Creek in 2021. 9
Figure 5. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of relative weights (W_r) for juvenile O. mykiss sampled in Stevens Creek in 2020 and 2021. 10

Appendix

Appendix A: Individual Measurements, Standard Weights (W_s), and Relative Weights (W_r) of *O. mykiss* Sampled During Fall 2021 Stevens Creek Juvenile Rearing Monitoring

Introduction

Stevens Creek originates in the Monte Bello Open Space Preserve in the Santa Cruz Mountains. It flows in a southeast direction primarily through open space for approximately 13 km before reaching Stevens Creek Reservoir. The western portion of the watershed where Stevens Creek originates remains relatively free of anthropogenic disturbance. Below the dam, Stevens Creek continues north for approximately 20 kilometers and empties into the San Francisco Bay at Whisman Slough near Stevens Creek Shoreline Nature Area Preserve. The eastern and northern potions of Stevens Creek flow across the Santa Clara County Valley floor, traversing mainly urbanized areas with patches of undeveloped park land. Stevens Creek drains a watershed of roughly 75 square kilometers.

Stevens Creek supports the federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) and is designated critical habitat from the creek's confluence with the San Francisco Bay to Stevens Creek Reservoir (70 FR 52570, September 2005). To better understand the health of juvenile *O. mykiss* in Stevens Creek, fish condition was analyzed for the first time following Valley Water's 2020 juvenile rearing monitoring season; 2021 marks the second year of fish condition analysis on Stevens Creek. The relative weight approach was used to evaluate fish condition due to the utility and ease with which it can be calculated and analyzed.

Background

Fish condition can be determined based on a measure of length and weight that represents the physiological or nutritional state of a fish. This analysis can be used to assess the effects of biotic and abiotic factors on the health of a population (Murphy et al. 1990, Cone 1989). Therefore, monitoring fish condition can be useful for informing management recommendations concerning fish populations.

Relationships between weight and length are often used for assessing population size structure and individual fish condition. Because fish weight is directly related to fish length, weight-

length data is not only used to predict one from the other, but it can also be used as an indicator of an individual's fatness (or condition) by measuring the variation from the expected weight for a certain length (LeCren 1951). The traditional approach to assessing fish condition involves the use of a 'condition factor,' which employs a fixed ratio to describe the relationship between fish length and weight (Murphy et al. 1991). The commonly used Fulton's condition factor (*K*) (Fulton 1904) is calculated as:

$$K = W / L^3$$

Where *W* is weight and *L* is length. Though it has the advantage of being easy to calculate, Fulton's condition factor has its drawbacks. First, it assumes isometric growth (power = 3, fish shape does not change with growth), which is rarely the case for most fish species (Froese 2006). Second, it is highly length- and species-dependent; therefore, it can only be reliably used to compare individuals with similar lengths and is practically impossible to compare across species. LeCren (1951) developed the relative condition factor (K_n) to address these issues, which is calculated with the formula:

$$K_n = W / W' \times 100$$

Where *W* is the actual weight of the individual fish and *W'* is the predicted length-specific mean weight for the population under study. While this approach solved the problem of comparing fish of different lengths and species, it is population-dependent and thus cannot be used to compare fish condition across populations.

The concept of 'relative weight' as a condition index was first introduced by Wege and Anderson (1978) for measuring the condition of largemouth bass (*Micropterus salmoides*). The relative weight approach compares fish weight to a benchmark, or standard weight, of that species based on weight-length data collected throughout its range. Wege and Anderson believed that relative weight had several advantages over other condition factors: 1) it is easy to calculate, 2) relative weight does not change with different units of measure, 3) standard weights compensate for inherent changes in body form, and 4) relative weight values can be compared between fish of different lengths and from different populations (Blackwell et al. 2000). For these reasons, the

relative weight index has become widely used in recent years as a measure of fish condition.

Methods

Data Collection

In fall 2021, length-weight data was collected from juvenile *O. mykiss* sampled during Valley Water's Stevens Creek index reach monitoring effort. The purpose of this annual monitoring effort, which in Stevens Creek began in 2020, is to document the abundance, distribution, and densities of *O. mykiss*. Sampling occurred at four sites in 2021 (SC004, SC005, SC006, and SC BONUS). For details on data collection methods, including sampling sites and fish processing procedures, please refer to the 2021 Juvenile *O. mykiss* Rearing Monitoring in Stevens Creek report (Valley Water 2022).

Calculations

The standard weight for each fish was calculated from their measured length using the following standard weight equation developed for juvenile *O. mykiss* ranging from 50 to 200 mm fork-length (Duffy 2006):

$$\log_{10} W_s = -4.790 + 2.928 \log_{10} FL$$

Where W_s is the standard weight in grams and FL is the fork-length in millimeters. This standard weight equation was developed using weight-length data from 121 *O. mykiss* populations ranging from southern Alaska through central California (Duffy 2006), including populations within the CCC DPS. The equation was formed using the regression-line-percentile technique (Murphy et al. 1990), which is based on 75th-percentile weights and uses $\log_{10}$ transformed data from a series of populations as the statistical population to be modeled (Blackwell et al. 2000).

The slope of the standard weight equation (b = 2.928) developed by Duffy (2006) indicates that juvenile *O. mykiss* ranging from Alaska to central California exhibit slight negative allometric growth (they become more elongated as they grow, $b < 3$).

Standard weight was used to calculate relative weight of individuals with the equation:

$$W_r = (W / W_s) \times 100$$

Where W_r is the relative weight and W is the weight of the fish being compared in grams. The factor 100 is used to express the equation as a percentage of W_s. Note that once $\log_{10}W_s$ was determined for each fish using the standard weight equation, the antilog of these values was used in the above equation to calculate W_r.

Lastly, individuals were categorized into 25-mm fork-length classes (hereafter referred to as length classes) in order to analyze for any length-related condition trends in the population sampled (Blackwell et al. 2000). The Kruskal-Wallis test was used to determine if there were statistically significant differences in W_r between length classes ($p < 0.05$). Considered the nonparametric alternative to the one-way ANOVA, the Kruskal-Wallis test was used for this study due to the non-normal data distributions and small sample sizes.

Relative Weight Target Range

The regression-line-percentile technique used to develop the standard weight equation above uses 75th-percentile weights; therefore, a W_r value of 100 (where the actual weight of the fish equals the standard weight) is not an average-sized fish. Rather, it means that across their range, 25% of the juvenile *O. mykiss* will have a W_r value greater than 100 while 75% will be less than 100. A fish with a W_r of 100 is thus considered to be in better-than-average condition. For the original development of the W_r index (Wege and Anderson 1978), 75th-percentile weights were also used as a standard. Anderson (1980) subsequently recommended that 95−105 be used as a W_r target range in order to aim for fish populations that are in above average condition, and it has since been widely used by fisheries managers.

Nonetheless, Murphy et al. (1991) cautioned against using a universal target range for optimal condition, believing that “optimal” will vary according to specific management objectives and environmental limitations. Targets for W_r should therefore be established according to the management goals for a given program, but further research is needed to evaluate appropriate W_r target ranges for juvenile *O. mykiss* populations under various management scenarios.

For the purposes of this report, the W_r target range of 95−105 (Anderson 1980) was used to define fish in optimal condition. This W_r target range may be modified in the future as more data is collected and as management objectives for Stevens Creek become established.

Interannual Comparisons

Juvenile *O. mykiss* monitoring occurred on Stevens Creek in 2020 and 2021. The population W_r of juvenile *O. mykiss* was compared between these years to evaluate for any fish condition changes over time. Statistical significance was tested using a Kruskal-Wallis test.

Results

Four *O. mykiss* were sampled during the 2021 Stevens Creek juvenile rearing monitoring season. While Duffy (2006) only included fish measuring from 50 to 200 mm fork-length in their standard weight equation, all *O. mykiss* sampled on Stevens Creek in 2021 were included in the analysis due to the small sample size (including one fish measuring > 200 mm fork-length). Measured weights ranged from 11.2 to 95.1 g with a mean weight of 58.0 g (SD=54.3). Measured fork-lengths ranged between 95 and 207 mm with a mean fork-length of 149 mm (SD=62).

Relative weight of the sampled population ranged from 108.4 to 116.3 with a mean W_r of 112.8 (SD=3.9) (Figure 1). All four of the *O. mykiss* sampled were above the 95−105 optimal range (>108).

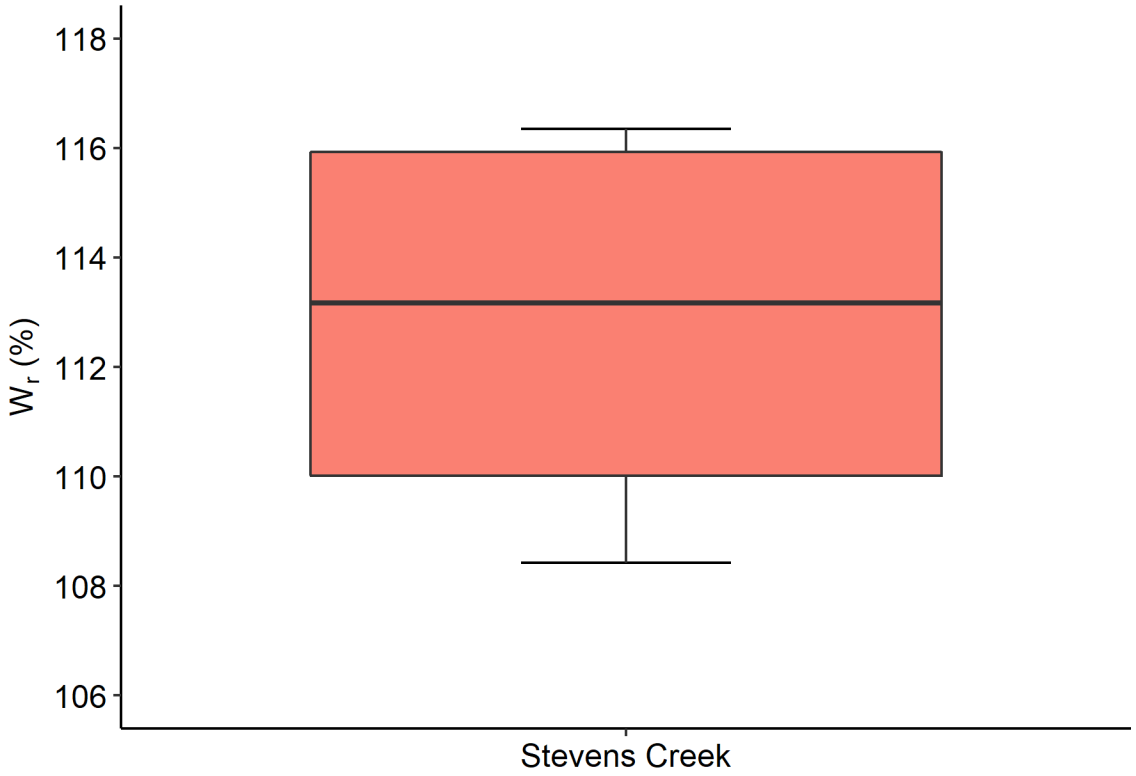


Figure 1. Boxplot (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of juvenile *O. mykiss* relative weights (W_r) of all individuals sampled in Stevens Creek (n = 4).

Relative weight plotted as a function of fork-length (adjusted R^2 = -0.422, 95% CI [-0.17, 0.20], p = 0.772) is shown in Figure 2. Summary statistics for W_r per 25-mm length class are provided in Table 1 and distributions are shown in Figure 3. There were no statistically significant differences in mean W_r among length classes as determined by a Kruskal-Wallis test (H = 1.80, df = 2, *p* = 0.407).

Individual fish measurements, W_s, and W_r are provided in Appendix A.

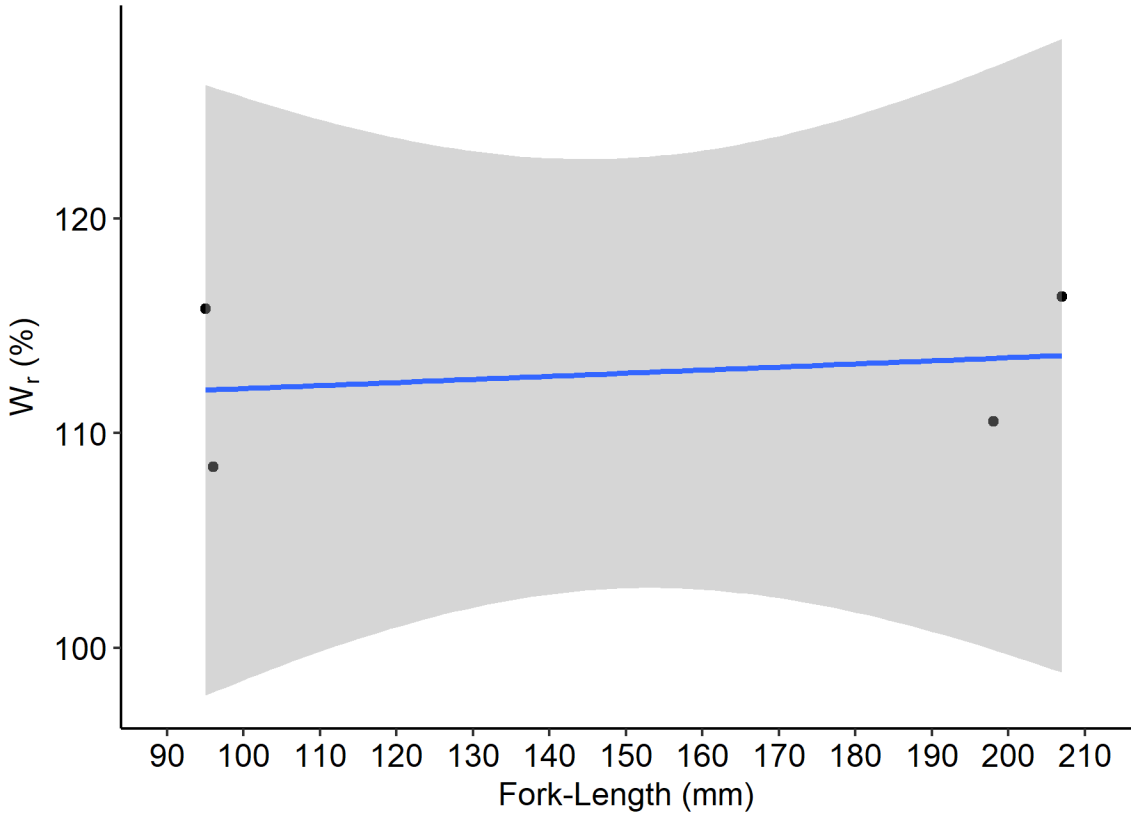


Figure 2. Relative weight (W_r) as a function of fork-length for juvenile *O. mykiss* sampled in Stevens Creek. Regression line in blue with confidence bands in gray.

Table 1. Summary statistics of Stevens Creek juvenile *O. mykiss* relative weights (W_r) per 25-mm length class. Means are presented as the value ± SD. Sample size = n.

Length Class (mm)	**n**	**Mean W_r (%)**	**W_r Range (%)**
76-100	2	112.11 ± 3.68	108.42−115.79
176-200	1	110.55	110.55
201-225	1	116.34	116.34

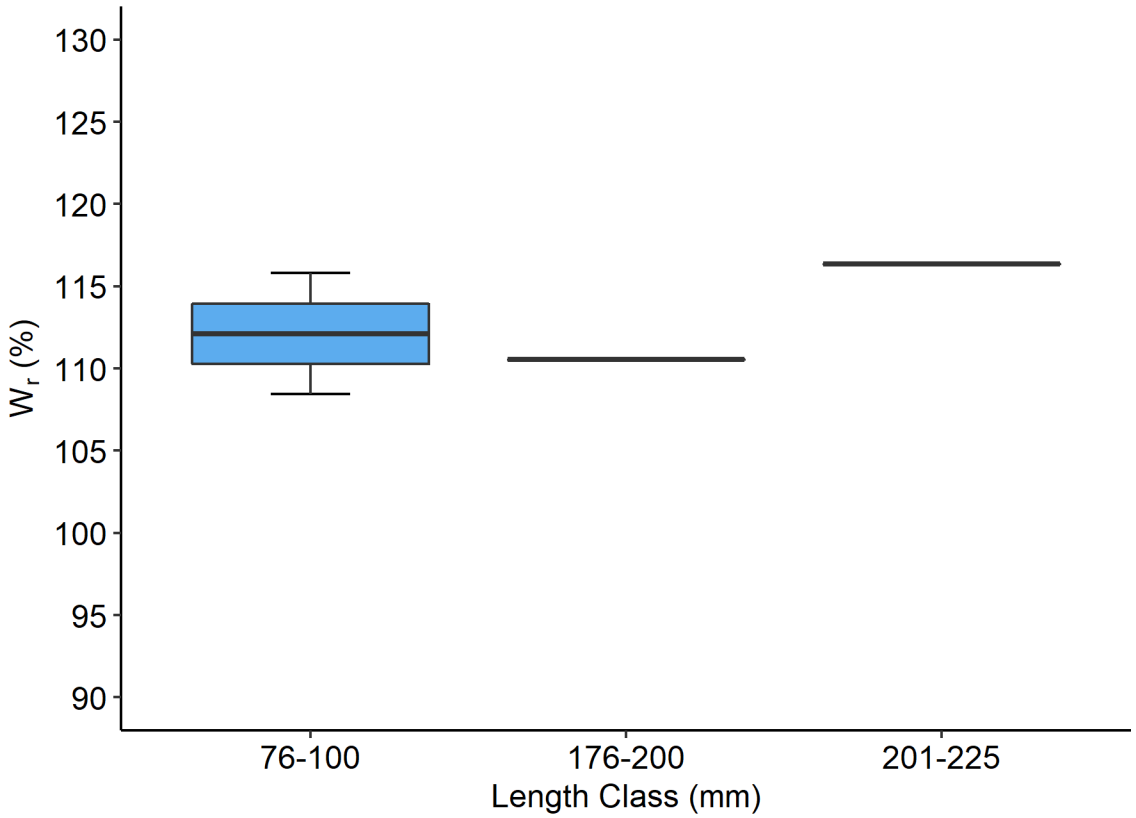


Figure 3. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) representing Stevens Creek juvenile *O. mykiss* relative weights (W_r) per 25-mm length class.

O. mykiss were captured at SC005 (n=3) and SC BONUS (n=1). W_r by capture site is shown in Figure 4. There were no statistically significant differences in mean W_r among length classes between 2020 and 2021 as determined by a Kruskal-Wallis test (H = 0.15, df = 1, p = 0.699). Summary statistics for W_r by creek and year are provided in Table 2 and distributions are shown in Figure 5.

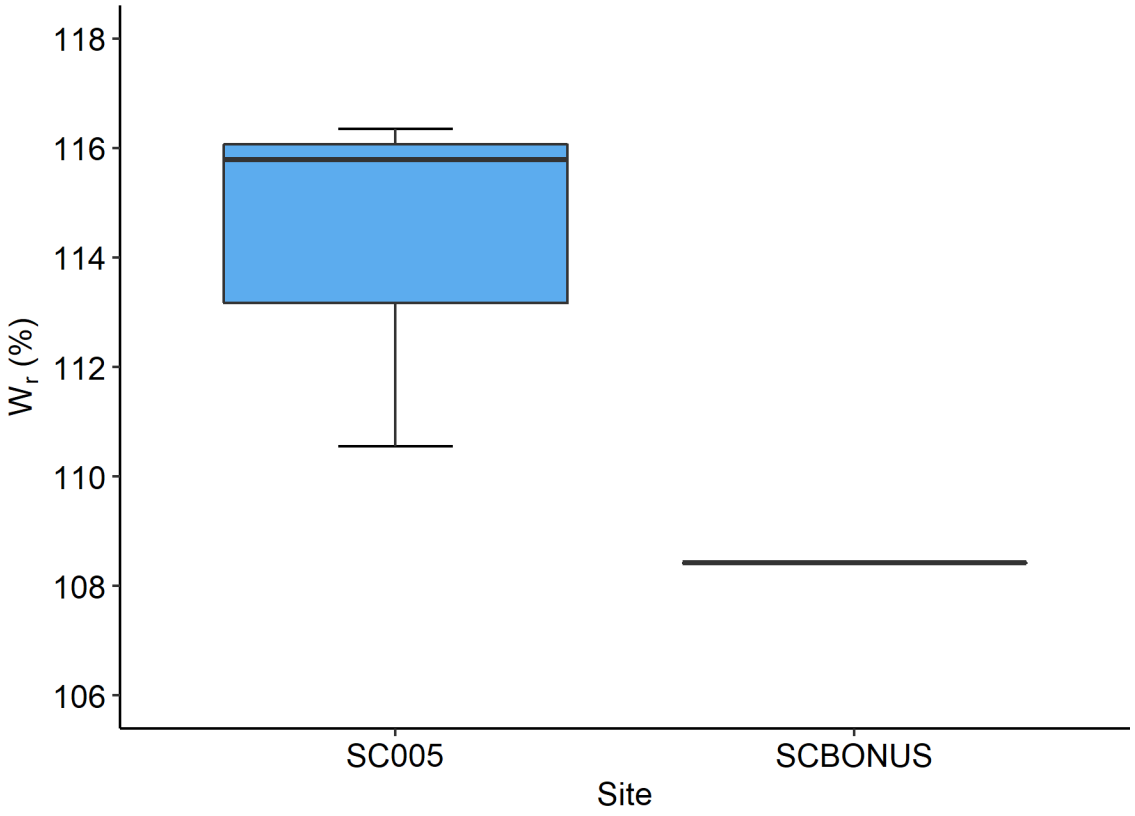


Figure 4. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of relative weights (W_r) for juvenile *O. mykiss* by sampling site in Stevens Creek in 2021.

Table 2. Summary statistics of juvenile *O. mykiss* population W_r for Stevens Creek in 2020 and 2021. Means are presented as the value ± SD. Sample size = n.

Year	n	Mean W_r (%)	W_r Range (%)
2020	47	110.8 ± 10.2	91.6–133.4
2021	4	112.8 ± 3.9	108.4–116.3

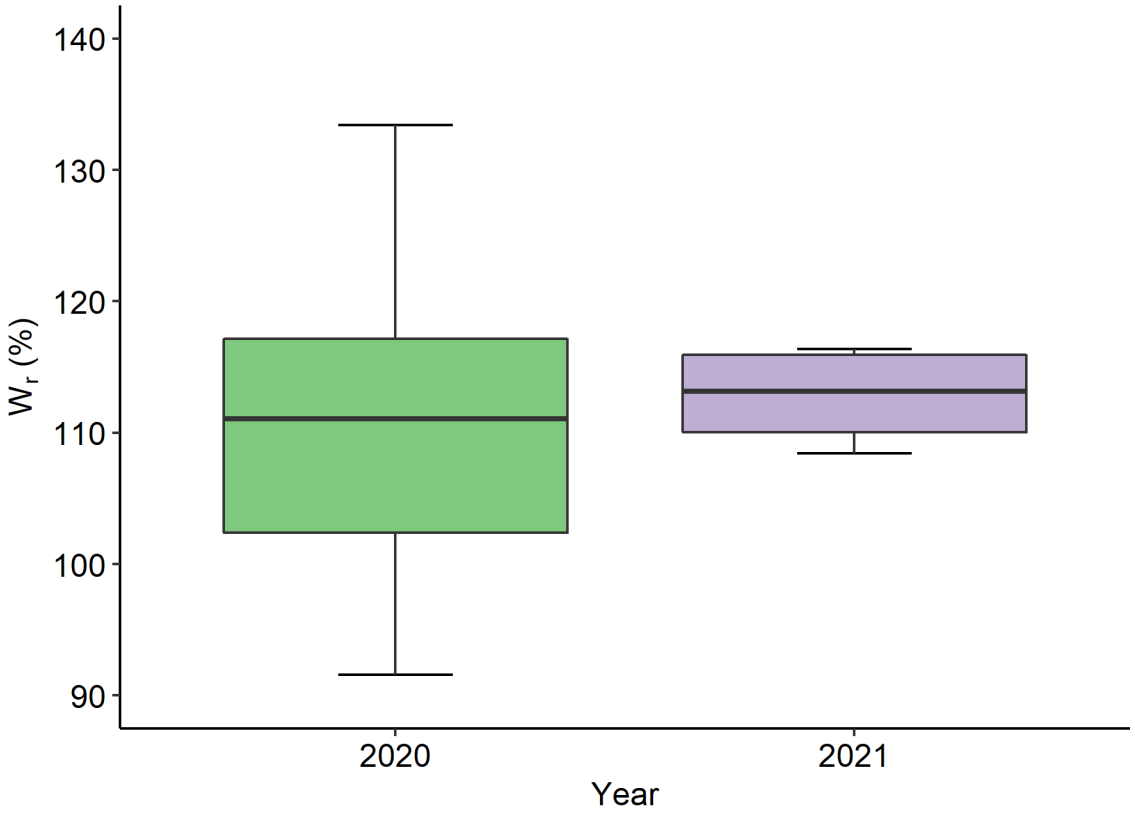


Figure 5. Boxplots (with the median, 25% and 75% quartiles, and whiskers extending 1.5 times the interquartile ranges) of relative weights (W_r) for juvenile *O. mykiss* sampled in Stevens Creek in 2020 and 2021.

Discussion

Though not statistically significant, the 201 to 225 mm length class (n=1) had the highest mean relative weight, but it should be noted that sample sizes for all represented length classes were too small to draw any reliable conclusions. The 76 to 100 mm length class had a higher mean W_r than the 176 to 200 length class. Our results show that there were no significant differences in W_r among length classes and that length was not correlated to W_r. This suggests that juvenile *O. mykiss* condition in Stevens Creek does not differ substantially between fish of varying lengths/ages. As more data is collected, any length-related trends in fish condition will become more apparent.

Sampling occurred at four locations, from downstream to upstream: SC004, SC005, SC BONUS, SC006. *O. mykiss* were only captured at SC005 and SC BONUS. The majority were captured at SC005, which had a higher mean W_r than SC BONUS. Only four fish were captured in 2021, but relative weights indicate all fish sampled were in excellent condition and above the optimal W_r target range of 95 to 105. Mean W_r was higher in 2021 than in 2020. In 2020, relative weights of juvenile *O. mykiss* in Stevens Creek ranged widely, but the majority of fish were in excellent condition with 94% of the sampled population falling either within or above the optimal W_r target range. Previous studies on salmonids have shown that fish weight or growth is inversely related to population density (Close and Anderson 1992, Keeley 2001), and that mean population W_r values are higher in areas where low densities of fish occur (Johnson et al. 1992). This is because individual fish weight and condition are likely to improve when there is reduced competition for food and other resources. The number of *O. mykiss* per meter captured during juvenile rearing sampling dropped from 0.20 in 2020 to 0.03 in 2021. Low numbers of *O. mykiss* in the system could be a contributing factor to high W_r in Stevens Creek. More reliable conclusions regarding the influence of density on fish condition can be made as sampling continues.

Fish with a high W_r can signify a waterbody with conditions ideal for growth, such as suitable habitat and water quality with abundant prey (Murphy et al. 1990, Liao et al. 1995). Presence of physical habitat features like large woody debris and undercut banks can contribute to improved juvenile *O. mykiss* condition and survival by providing refugia from predators and high flow velocities. All stations sampled had some amount of habitat complexity in the form of undercut banks, large woody debris, root wads, emergent vegetation, boulders, or some combination thereof that could be used as refugia for *O. mykiss*. Riffles were also present that could provide fast water feeding habitat.

Earlier studies have also found relationships between W_r and food supply (Flickinger and Bulow 1993, Liao et al. 1995) and shown that prey biomass is positively correlated with fish condition. For example, young of the year *O. mykiss* fed to satiation exhibited increased growth rates at increased temperatures (up to 19º C) in a laboratory setting

(Myrick and Cech 2005). Some benthic macroinvertebrate (BMI) sampling has been conducted on Stevens Creek below and above the reservoir periodically between 2006 and 2020 by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) for use as an indicator of water quality. Three sites sampled by SCVURPPP in 2019 and 2020 fell within the area where Valley Water's *O. mykiss* sampling occurred. BMI orders detected in 2019 and 2020 are provided in Table 3 (CEDEN 2022).

Table 3. BMI orders detected between Stevens Reservoir and Highway 280 in 2019 and 2020.

Acrochaetiales	Cymbellales	Naviculales	Thalassiophysales
Amphipoda	Diptera	Nostocales	Thalassiosirales
Aulacoseirales	Ephemeroptera	Odonata	Trichoptera
Bacillariales	Fragilariales	Oedogoniales	Trombidiformes
Basommatophora	Hemiptera	Oscillatoriales	Vaucheriales
Cladophorales	Hypsogastropoda	Plecoptera	Veneroida
Cocconeidales	Licmophorales	Pseudanabaenales	Zygnematales
Coleoptera	Mastogloiales	Stephanodiscales	
Coscinodiscales	Megaloptera	Surirellales	
Cryptomonadales	Melosirales	Tabellariales	

Water temperature can likewise influence fish condition and has been documented to affect growth and size of *O. mykiss* and other salmonids through effects on metabolism, behavior, and mortality (Bjornn and Reiser 1991). According to NFMS (2016), optimal water temperatures for juvenile *O. mykiss* growth range from 12 to 19°C. However, the majority of research done on suitable temperatures for salmonids has been conducted in the Pacific Northwest where environmental conditions are much different than the Central California Coast. More recent research indicates that salmonid populations may benefit from local adaptation (Zillig et al 2021). However, at extreme upper temperatures growth may be reduced (Bjornn and Reiser 1991).

The high W_r results in Stevens Creek suggest that environmental conditions are favorable for juvenile *O. mykiss.* However, the population is very low, which is

somewhat concerning. A limiting factors analysis determined that structural and flow-related barriers to fish passage and lack of overwintering habitat likely have the greatest influence on steelhead populations in Stevens Creek (Stillwater Sciences 2004). According to the National Oceanic and Atmospheric Administration's (NOAA's) National Integrated Drought Information System (NIDIS), Santa Clara County is currently in a drought. The majority of the county, including Stevens Creek Watershed, is categorized as "extreme drought," meaning that water supply is inadequate for agriculture, wildlife, and urban needs and reservoirs are extremely low. Drought can result in reduced connectivity to suitable habitat, limiting movement and overall habitat availability. Drought conditions can have immediate effects on fish and invertebrate species' abundance, growth, survival, location in the watershed or migration capabilities. Effects to aquatic ecosystems may be short-term or long-lasting, depending on the severity and duration of the drought. The drought conditions are likely influencing *O. mykiss* populations in Stevens Creek.

It is worth noting that human error has the potential to skew results. Accurately measuring the length and weight of fish can be difficult in the field, especially with small fish and when they need to be measured quickly to avoid mortality. Furthermore, issues taring the scale in the field and excess water on the equipment (scale and measuring board) can affect the weight measurement. Although Stevens Creek *O. mykiss* had a considerably high W_r, the results are within reason when compared to other populations of juvenile *O. mykiss* from Alaska through northern California. McLaughlin (2009) calculated the average W_r for over 100 juvenile *O. mykiss* populations of various size throughout northern California, Oregon, Washington, and Alaska. Average W_r for populations in McLaughlin's dataset ranged from 78.2 to 118.1 with an average of 97.7. The sampled population in Stevens Creek had an average W_r of 112.8, and thus falls within the aforementioned range.

Juvenile *O. mykiss* sampled in Stevens Creek in 2020 and 2021 were overall in healthy condition. As previously stated, results are limited at this time because 2020 was the first year of sampling in Stevens Creek and the capture rate was low in 2021. Interannual comparisons will become possible with continued juvenile *O. mykiss* rearing

sampling, and any climatic variation (e.g., dry, warm years vs. wet, cold years) and operational changes (e.g., flow releases or reductions) can be incorporated into the results to determine if there is any correlation between these factors and fish condition. Due to the advantage of using W_r as a condition index, future comparisons can also be made between Stevens Creek and other *O. mykiss* populations in Santa Clara County.

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Appendix A

Individual Measurements, Standard Weights (W_s), and Relative Weights (W_r) of *O. mykiss* Sampled During Fall 2021 Stevens Creek Watershed Juvenile Rearing Monitoring

FishID	Weight (g)	Fork-length (mm)	Ws (g)	Wr (%)	Site
2021STV001	95.1	198	86.02718	110.5465	SC005
2021STV002	11.6	95	10.01785	115.7933	SC005
2021STV003	114	207	97.98536	116.3439	SC005
2021STV004	11.2	96	10.32976	108.4246	SCBONUS

Stevens Creek *Oncorhynchus mykiss* 2020 – 2021 Migration Monitoring Using Passive Integrated Transponder Tags



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January 2022

Contents

Introduction 1
Methods 2
Fish PIT Tagging 2
Antenna Construction and Operation 4
Results and Discussion 8
Conclusion 13
References 13

Figures

Figure 1. 2020 Stevens Creek juvenile O. mykiss PIT tagging stations and PIT antenna location. 3
Figure 2. 12 mm (top) and 23 mm (bottom) HDX PIT tags. 4
Figure 3. Swim-through PIT antenna on Stevens Creek. Arrows indicate the ends of the antenna loop. 5
Figure 4. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag read ranges at the Stevens Creek PIT antenna 8
Figure 5. 2020-2021 O. mykiss tagging locations and relative paths to the Stevens Creek PIT antenna. Numbers in legend indicate last four digits of O. mykiss PIT tag number. 10
Figure 6. O. mykiss tracked by the Stevens Creek PIT antenna compared to daily flow on Stevens Creek at ALERT gage 5035 (6.5 km downstream of antenna). Numbers in legend indicate the last four digits of O. mykiss PIT tag numbers. 12

Tables

Table 1. Stevens Creek PIT antenna details. 6
Table 2. Stevens Creek PIT antenna recorded outage type and duration during the 2020-2021 monitoring period. 7
Table 3. O. mykiss tag number and associated information of each fish detected at the Stevens Creek PIT antenna during the 2020-2021 migration season 9

Appendices

Appendix A: PIT Tag Master List

Introduction

Stevens Creek consists of approximately 32 kilometers of channel and originates in the Monte Bello Open Space Preserve in the Santa Cruz Mountains. The western portion of the watershed where Stevens Creek originates remains relatively free of anthropogenic disturbance. The creek flows southeasterly through the Stevens Creek County Park before entering Stevens Creek Reservoir, then continues north and empties into the San Francisco Bay at the Whisman Slough next to Mountain View's Shoreline Park. The eastern and northern portions of Stevens Creek flow across the Santa Clara County valley floor, traversing mainly urbanized areas with patches of undeveloped park land. Stevens Creek drains a watershed of roughly 75 square kilometers.

Stevens Creek supports the federally threatened Central California Coast steelhead (*Oncorhynchus mykiss; O. mykiss*) Distinct Population Segment (DPS) and is designated critical habitat from the creek's confluence with the San Francisco Bay to Stevens Creek Dam (70 FR 52570, September 2005).

In fall 2020, Valley Water conducted the first year of juvenile *O. mykiss* rearing monitoring in Stevens Creek to gain a better understanding of *O. mykiss* populations within the system by documenting their abundance and distribution. A total of thirty-seven appropriately sized *O. mykiss* were captured tagged with passive integrated transponder (PIT) tags during the sampling effort in order to track their movement within Stevens Creek (Valley Water 2021).

A PIT tag is a small passive transponder that contains a unique 15-digit number, which allows researchers to tag fish with distinct codes. As passive tags, they do not require a battery to produce a signal. Instead, the signal is generated by a radio-frequency identification (RFID) system that sends a radio frequency into the environment. These systems, often referred to as arrays or antenna systems, are deployed at sites of interest within a stream in order to track fish movement. When a tagged fish is within range and detected by the RFID system, the reader records the unique PIT tag number and the associated date and time of that detection. One stationary tag reading system was deployed on Stevens Creek for the 2020-2021 monitoring season.

The goal of this study was to gain a better understanding of juvenile *O. mykiss* movement and migratory timing and behavior in Stevens Creek. Additionally, this study aimed to reveal what proportion of the tagged population showed migratory tendencies.

Methods

Fish PIT Tagging

In October 2020, juvenile *O. mykiss* rearing monitoring was conducted at six sampling stations in Stevens Creek (Figure 1). Multi-pass depletion backpack electrofishing was used at each station to determine the presence of *O. mykiss* as well as the composition of other fish species in the system (Valley Water 2021). All *O. mykiss* with a fork-length of 65 mm or greater were tagged during each sampling event. *O. mykiss* with a fork-length greater than or equal to 65 mm, but less than 150 mm, received a 12 mm half-duplex (HDX) PIT tag. *O. mykiss* with a fork-length of 150 mm or greater received a 23 mm HDX PIT tag (Figure 2). All PIT tagging was conducted in accordance with the PIT Tag Marking Procedures Manual (CBFWA 2014) by staff trained in the procedure.

A total of thirty-seven *O. mykiss* were tagged in Stevens Creek in 2020. One fish received a 23 mm tag and the remaining thirty-six fish received a 12 mm tag. Tagging locations coincide with the juvenile rearing monitoring sampling stations and can be seen in Figure 1.

PIT tag numbers and associated biological data for all fish tagged by Valley Water in Santa Clara County are included in Appendix A.

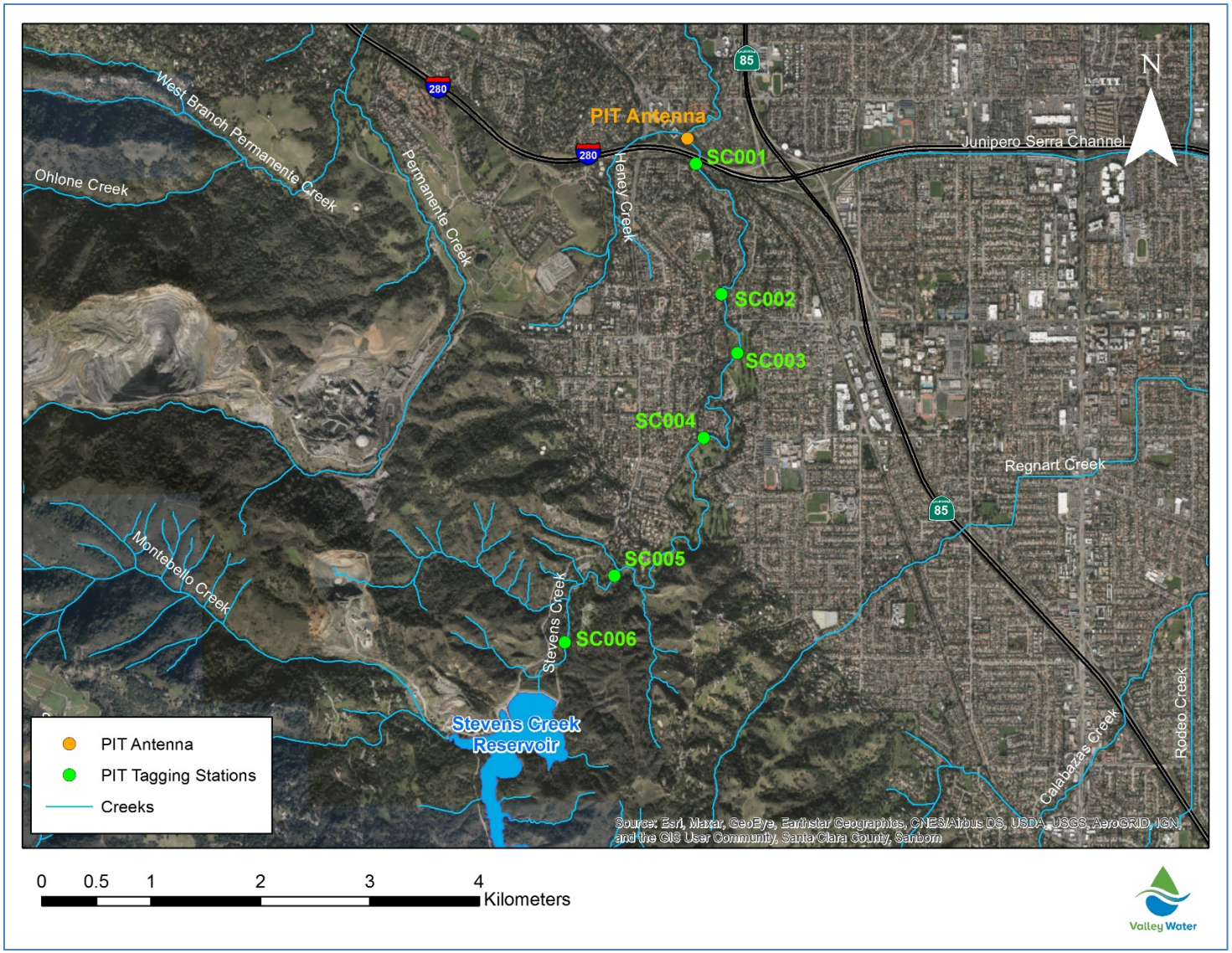


Figure 1. 2020 Stevens Creek juvenile *O. mykiss* PIT tagging stations and PIT antenna location.

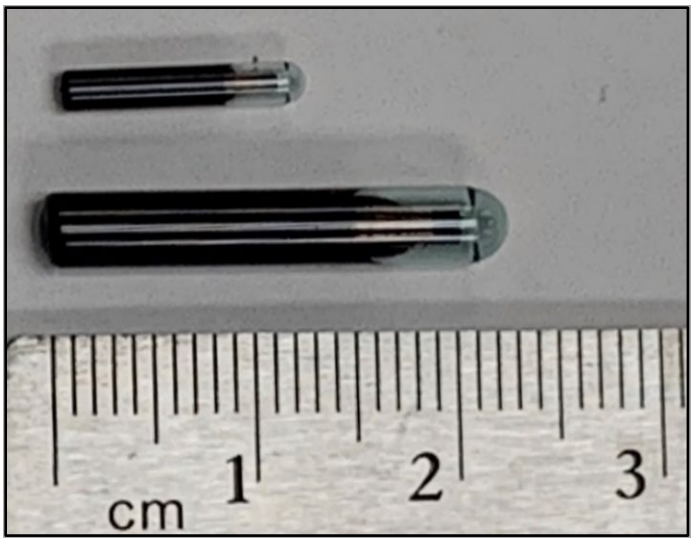


Figure 2. 12 mm (top) and 23 mm (bottom) HDX PIT tags.

Antenna Construction and Operation

One stationary PIT antenna was installed on Stevens Creek and used HDX RFID technology. The basic components of the HDX array included an RFID reader, a power source, a tuning capacitor, and an antenna. The reader stored the following data when a PIT tag was detected: PIT tag number, date and time stamp, number of times the tag was detected (e.g., 10 detections), and number of scans since the last detection. Detections recorded by the antenna indicated that a tagged individual was in proximity of the antenna at a given time but did not indicate direction of movement. Therefore, assumptions were made about direction based on the fish release point after tagging occurred and the position of the antenna in the system. It was also assumed that detections were of the target species and not tags that were either expelled and mobile in the system or in the digestive system of a predatory species.

The Stevens Creek PIT antenna was installed and began operation on December 17, 2020. The 2020-2021 monitoring period was the first *O. mykiss* migration season for which this antenna was deployed. The antenna was located immediately upstream of the Heney Creek confluence and downstream of all the PIT tagging stations in order to detect potential outmigration (see Figure 1). The antenna was a swim-through design

comprised of two loops of 10 AWG copper wire encased in a PVC jacket. Landscape lighting wire was used so that the two loops were joined. The top of the antenna was supported with a static line anchored to a tree on one side and a stainless steel eye strap attached to the concrete abutment of Heney Creek on the other. The bottom of the antenna was secured to the stream bed with metal stakes pounded into the substrate (Figure 3). The antenna wire was attached to the top and bottom supports with plastic zip ties. Additional antenna details are provided in Table 1.



Figure 3. Swim-through PIT antenna on Stevens Creek. Arrows indicate the ends of the antenna loop.

Table 1. Stevens Creek PIT antenna details.

Antenna Style	Swim-through
Wire Gauge	10 AWG
Dimensions	0.6 m tall; 4.7 m long
Number of Loops	2
Protective Housing	None
Braided Tail Length (between antenna loop and tuning capacitor)	1.9 m
Tuner Type	ATC Autotuner
Length of Twinax (between tuning capacitor and reader)	19.5 m
Reader Type	Oregon RFID single reader

The antenna was powered by four twelve-volt deep cycle marine batteries that were replaced every seven to ten days in order to maintain continuous antenna operation. Additionally, a marker tag that was programmed to be detected every 30 minutes was installed inside the detection zone of the antenna. The marker tag helped verify continuous antenna operation and demarcate the timing of any outages.

The antenna provided complete lateral coverage of the channel during most flows, but during large storm events when the floodplain was inundated, areas along the channel margin did not receive coverage. Only one storm event large enough to potentially cause the above scenario occurred during the 2020-2021 monitoring season. The read range consistently spanned the entire height of the antenna between the top and bottom wires for both the 23 mm tags and 12 mm tags. The 23 mm tags had a read range of 0.6 m up- and downstream of the antenna and 0.5 m above the antenna. For the 12 mm tags, the read range up- and downstream of the antenna was 0.3 m, and the read range above the antenna was 0.2 m. On two occasions, the batteries ran out of power before they could be replaced resulting in antenna outages (Table 2).

The antenna was powered down for the season on June 1, 2021.

Table 2. Stevens Creek PIT antenna recorded outage type and duration during the 2020-2021 monitoring period.

Outage Type	Outage Start	Outage End
Low battery voltage	12/29/2020 20:57	12/31/2020 12:22
Low battery voltage	3/20/2021 22:26	3/22/2021 09:13

Estimates of the portion of the water column effectively scanned were made using physically measured PIT tag read ranges and outputs from the HEC-RAS hydraulic modeling in Stevens Creek. The antenna was installed within a run, thus the nearest cross section at a run was used for reference. Based on the modeling results, it is estimated that the Stevens Creek PIT antenna provided complete coverage of the water column up to 260 cfs for 12 mm tags and 497 cfs for 23 mm tags (Figure 4). However, these results do not account for inundation of the floodplain.

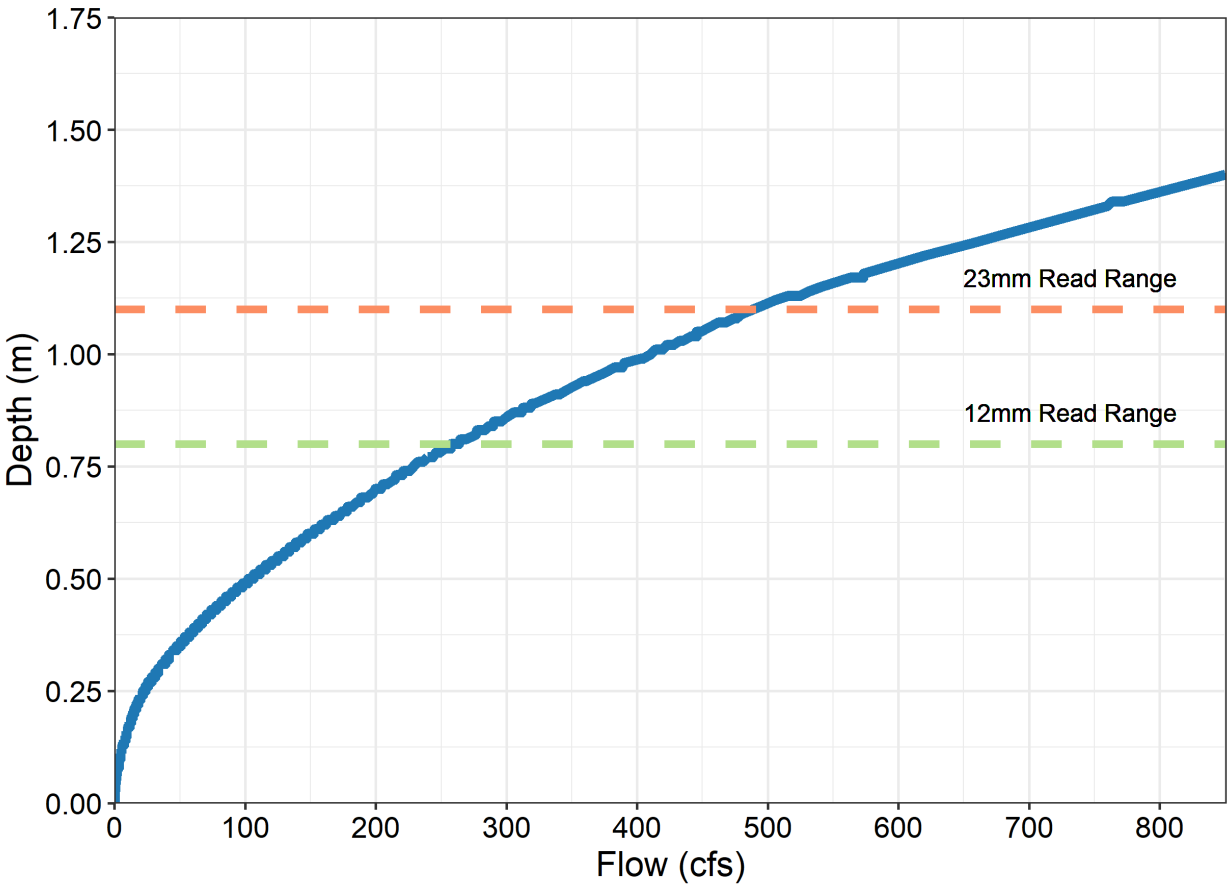


Figure 4. Modeled depth-to-flow cross sectional analysis overlaid with 12 mm and 23 mm tag read ranges at the Stevens Creek PIT antenna.

Results and Discussion

O. mykiss were PIT tagged at six locations on Stevens Creek in October 2020 (Valley Water 2021). A total of two individual tags implanted in *O. mykiss* were detected at the Stevens Creek PIT antenna during the 2020-2021 migration season (Table 3). Both of the tags detected were 12 mm tags, and both fish were tagged at tagging station SC002, approximately 1.3 km upstream of the antenna. Relative paths of the detected *O. mykiss* from their tagging location to the PIT antenna are shown in Figure 5.

Table 3. O. mykiss tag number and associated information of each fish detected at the Stevens Creek PIT antenna during the 2020-2021 migration season.

Date Tagged	Date Last Detected	Tag ID	Tagging Station	Fork-length (mm)
10/29/2020	1/31/2021	982.126058146861	SC002	69
10/29/2020	1/24/2021	982.126058146886	SC002	70

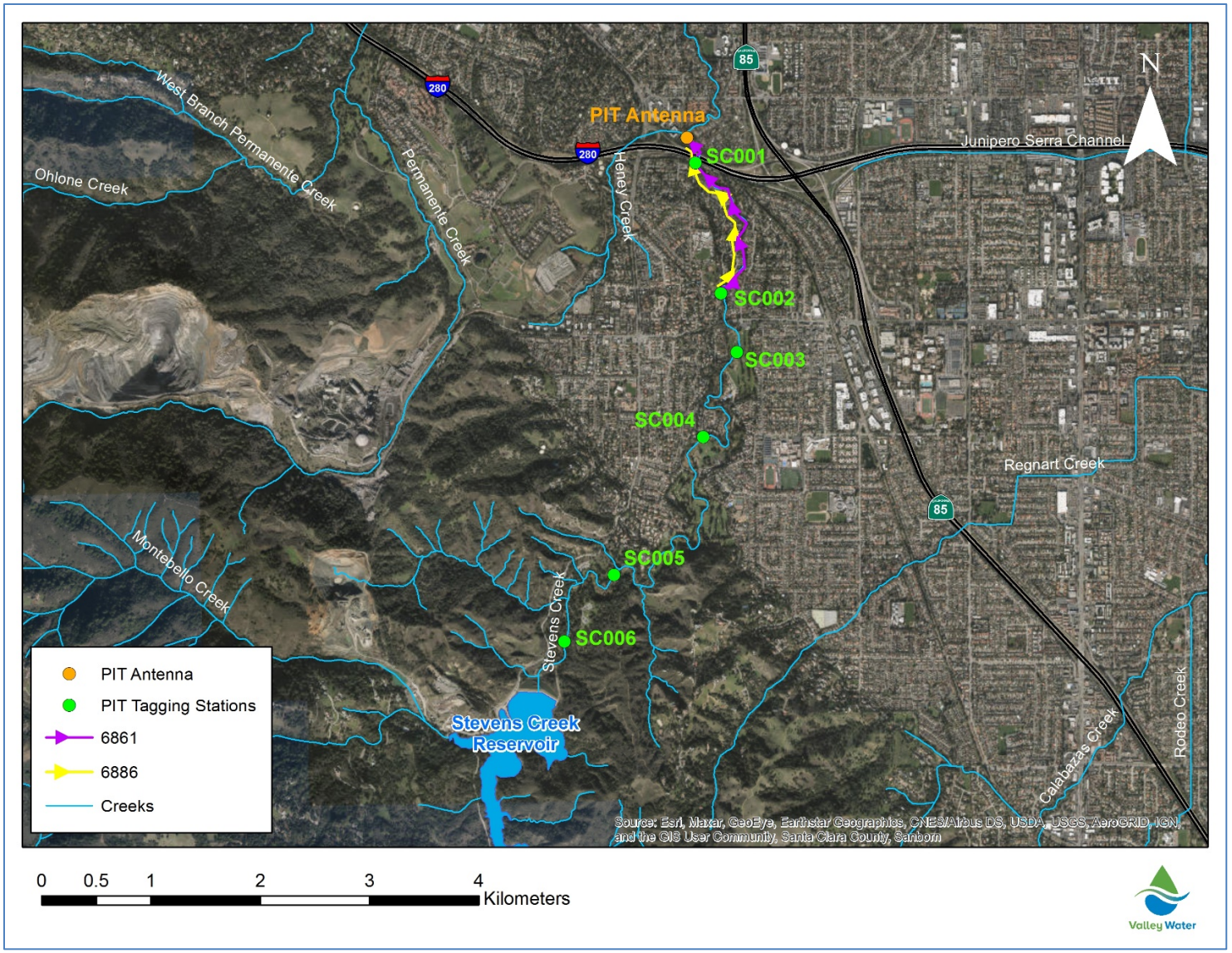


Figure 5. 2020-2021 *O. mykiss* tagging locations and relative paths to the Stevens Creek PIT antenna. Numbers in legend indicate last four digits of *O. mykiss* PIT tag number.

O. mykiss #6861 (last four digits of PIT tag identification number) was detected on multiple consecutive days during the monitoring season; these days were January 29, 30, and 31, 2021. *O. mykiss* #6886 was only detected on a single day during the monitoring season (January 24, 2021).

Movement of *O. mykiss* at the Stevens Creek PIT antenna appeared to be in association with flow events, and all detections occurred at flows under 10 cfs (Figure 6). The single detection of *O. mykiss* #6886 occurred around a small storm event (approximately 8 cfs), whereas the detections of *O. mykiss* #6861 took place following the largest storm event of the season at the end of January (442 cfs). It is uncertain whether the activity of either fish was migratory or local movement, and since the PIT antenna does not provide directional information, it is difficult to definitively conclude the direction in which the *O. mykiss* were traveling. However, because *O. mykiss* #6886 was only detected once by the PIT antenna, it is possible that the fish was out-migrating or showing migratory tendencies. The multiple detections of *O. mykiss* #6861, on the other hand, suggest that the fish was moving around in the system following the large storm event. Whether it continued to migrate downstream or remained in the area is unknown.

The antenna experienced two outages over the course of the monitoring season, but it is unlikely that fish went undetected during those times. Both outages were less than two days in duration and did not occur around any storm events.

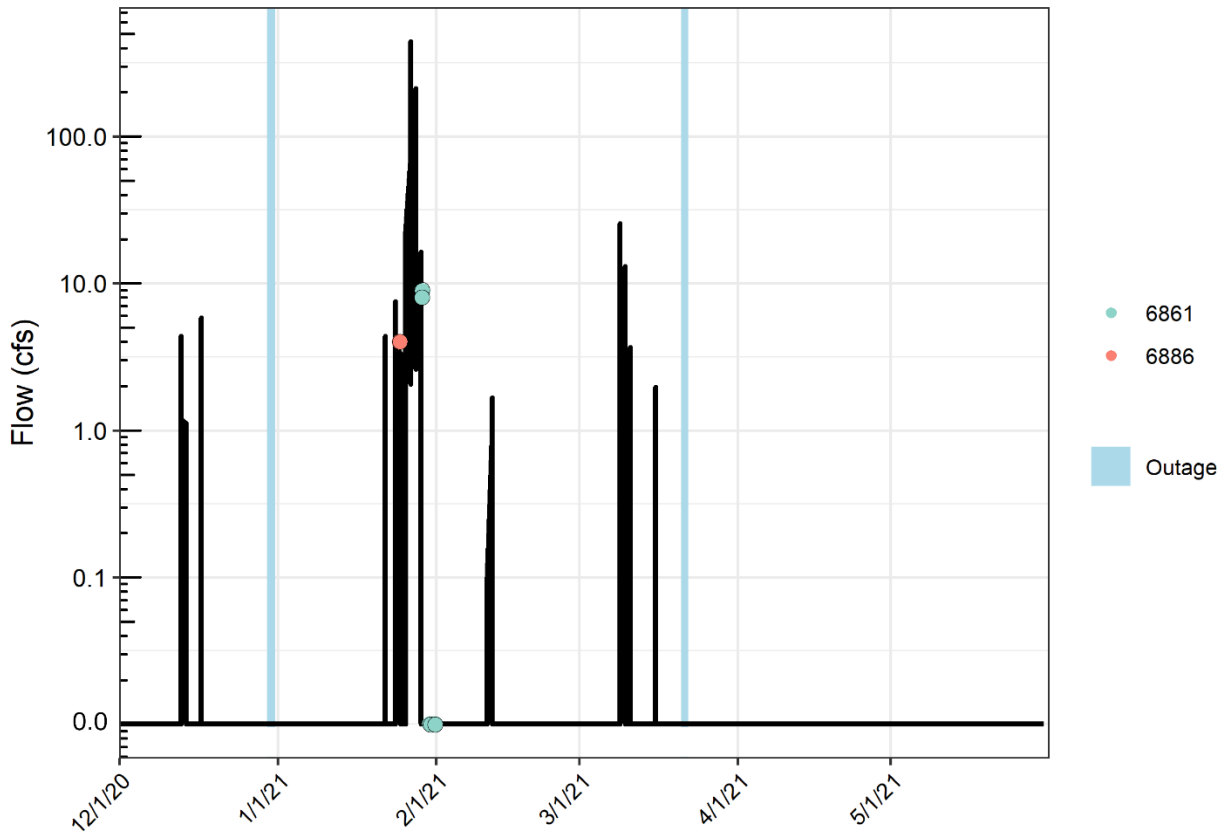


Figure 6. *O. mykiss* tracked by the Stevens Creek PIT antenna compared to daily flow (cubic feet per second, shown on a logarithmic scale) on Stevens Creek at ALERT gage 5035 (6.5 km downstream of antenna). Numbers in legend indicate the last four digits of *O. mykiss* PIT tag numbers.

The *O. mykiss* detected measured 69 mm and 70 mm in fork-length when tagged. These lengths were recorded approximately 3 months prior to the detection dates; therefore, the fish were likely larger than when they were initially tagged. According to Moyle (2002), in small streams with low summer flows, much like Stevens Creek, young-of-the-year steelhead measure 50–90 mm, and fish at the end of their second year measure 100–160 mm. Smith and Leicester (2016) aged 32 fish from Guadalupe Creek in the Guadalupe River Watershed and found that young-of-the-year *O. mykiss* ranged from 85–114 mm, and fish in their second year ranged from 110–195 mm. This is a faster growth rate than predicted by Moyle (2002) but is expected in warmer, more

productive systems. Based on both Moyle (2002) and Smith and Leicester (2016), the *O. mykiss* detected by the Stevens Creek PIT antenna were in their first year.

Conclusion

This first season of monitoring showed that tracking *O. mykiss* using PIT technology is a viable method for studying fish movement in Stevens Creek. Fish were detected, and overall, the antenna system operated as intended for the entire duration of the monitoring season.

Because this was only the first season of PIT tag monitoring in Stevens Creek, results are limited at this time. In addition, the overall low flow conditions experienced during the 2020-2021 monitoring season reduced the opportunity for *O. mykiss* movement throughout the system. A more robust dataset will develop as PIT tagging continues over the next several years.

References

Columbia Basin Fish and Wildlife Authority (CBFWA) PIT Tag Steering Committee. 2014. PIT Tag Marking Procedure Manual, Version 3.0. Available at https://www.ptagis.org/docs/default-source/ptagis-program-documents/2014-mark-procedures-manual.pdf?sfvrsn=2

Moyle, B. P., et al. *Inland Fishes of California.* University of California Press, 2002.

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Valley Water. 2021. 2020 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in Stevens Creek.

Appendix A

PIT Tag Master List

12/16/2013	Guadalupe River	O. mykiss	-	134	982.000361656209
12/16/2013	Guadalupe River	O. mykiss	-	136	982.000361656215
12/16/2013	Guadalupe River	O. mykiss	-	155	982.000361656218
12/16/2013	Guadalupe River	O. mykiss	-	142	982.000361656222
12/16/2013	Guadalupe River	O. mykiss	-	-	982.000361656226
12/16/2013	Guadalupe River	O. mykiss	-	129	982.000361656230
12/16/2013	Guadalupe River	O. mykiss	-	133	982.000361656235
12/16/2013	Guadalupe River	O. mykiss	-	163	982.000361656237
12/16/2013	Guadalupe River	O. mykiss	-	125	982.000361656243
12/16/2013	Guadalupe River	O. mykiss	-	172	982.000361656249
12/16/2013	Guadalupe River	O. mykiss	-	151	982.000361656258
12/16/2013	Guadalupe River	O. mykiss	-	110	982.000362992258
12/16/2013	Guadalupe River	O. mykiss	-	160	982.000361656260
12/16/2013	Guadalupe River	O. mykiss	-	129	982.000361656263
12/16/2013	Guadalupe River	O. mykiss	-	230	982.000361656267
12/16/2013	Guadalupe River	O. mykiss	-	118	982.000362992269
12/16/2013	Guadalupe River	O. mykiss	-	175	982.000361656269
12/16/2013	Guadalupe River	O. mykiss	-	144	982.000361656274
12/16/2013	Guadalupe River	O. mykiss	-	122	982.000361656277
12/16/2013	Guadalupe River	O. mykiss	-	142	982.000361656278
12/16/2013	Guadalupe River	O. mykiss	-	112	982.000362992279
12/16/2013	Guadalupe River	O. mykiss	-	149	982.000361656280
12/16/2013	Guadalupe River	O. mykiss	-	135	982.000361656294
12/16/2013	Guadalupe River	O. mykiss	-	106	982.000362992296
12/16/2013	Guadalupe River	O. mykiss	-	122	982.000362992356
1/17/2014	Guadalupe River	O. mykiss	-	135	982.000361656216
1/17/2014	Los Gatos Creek	O. mykiss	-	115	982.000361656217
1/17/2014	Los Gatos Creek	O. mykiss	-	164	982.000361656229
1/17/2014	Guadalupe River	O. mykiss	-	156	982.000361656238
1/17/2014	Guadalupe River	O. mykiss	-	133	982.000361656247
1/17/2014	Guadalupe River	O. mykiss	-	120	982.000361656250
1/17/2014	Guadalupe River	O. mykiss	-	115	982.000361656252
1/17/2014	Guadalupe Creek	O. mykiss	-	80	982.000362992263
1/17/2014	Guadalupe River	O. mykiss	-	190	982.000361656264
1/17/2014	Guadalupe River	O. mykiss	-	150	982.000361656265
1/17/2014	Guadalupe Creek	O. mykiss	-	104	982.000362992272
1/17/2014	Guadalupe Creek	O. mykiss	-	85	982.000362992278
1/17/2014	Los Gatos Creek	O. mykiss	-	142	982.000361656288
1/17/2014	Guadalupe Creek	O. mykiss	-	93	982.000362992289
1/17/2014	Guadalupe Creek	O. mykiss	-	79	982.000362992290
1/17/2014	Guadalupe River	O. mykiss	-	119	982.000361656290

1/17/2014	Los Gatos Creek	O. mykiss	-	126	982.000361656298
1/17/2014	Los Gatos Creek	O. mykiss	-	89	982.000362992298
1/17/2014	Los Gatos Creek	O. mykiss	-	138	982.000361656299
1/17/2014	Guadalupe Creek	O. mykiss	-	75	982.000362992302
1/17/2014	Guadalupe Creek	O. mykiss	-	110	982.000362992303
1/17/2014	Guadalupe Creek	O. mykiss	-	155	982.000361656305
1/17/2014	Guadalupe Creek	O. mykiss	-	91	982.000362992306
1/17/2014	Guadalupe Creek	O. mykiss	-	91	982.000362992312
1/17/2014	Guadalupe Creek	O. mykiss	-	92	982.000362992315
1/17/2014	Guadalupe Creek	O. mykiss	-	71	982.000362992325
1/17/2014	Guadalupe Creek	O. mykiss	-	102	982.000362992327
1/17/2014	Guadalupe Creek	O. mykiss	-	79	982.000362992328
1/17/2014	Guadalupe Creek	O. mykiss	-	80	982.000362992330
1/17/2014	Guadalupe Creek	O. mykiss	-	110	982.000362992333
1/17/2014	Guadalupe Creek	O. mykiss	-	69	982.000362992340
1/17/2014	Guadalupe River	O. mykiss	-	138	982.000361656521
2/12/2014	Guadalupe River	O. mykiss	-	148	982.000361656219
2/12/2014	Guadalupe River	O. mykiss	-	189	982.000361656225
2/12/2014	Guadalupe River	O. mykiss	-	149	982.000361656227
2/12/2014	Guadalupe River	O. mykiss	-	179	982.000361656231
2/12/2014	Guadalupe River	O. mykiss	-	147	982.000361656242
2/12/2014	Guadalupe River	O. mykiss	-	156	982.000361656244
2/12/2014	Guadalupe River	O. mykiss	-	132	982.000361656272
2/12/2014	Guadalupe River	O. mykiss	-	193	982.000361656291
2/21/2014	Los Gatos Creek	O. mykiss	-	116	982.000361656213
2/21/2014	Los Gatos Creek	O. mykiss	-	142	982.000361656270
2/21/2014	Guadalupe River	O. mykiss	-	145	982.000361656311
2/21/2014	Los Gatos Creek	O. mykiss	-	112	982.000361656454
3/14/2014	Guadalupe River	O. mykiss	-	153	982.000361654515
3/15/2014	Pond A8	striped bass		520	982.000362654458
3/15/2014	Pond A8	striped bass		500	982.000362654476
3/15/2014	Pond A8	striped bass		530	982.000362655000
3/15/2014	Pond A8	striped bass		500	982.000362654505
3/15/2014	Pond A8	striped bass		440	982.000362654514
3/15/2014	Pond A8	striped bass		470	982.000362654539
4/17/2014	Pond A5	Leopard Shark	-	1219	982.000362654450
4/17/2014	Pond A5	Leopard Shark	-	838	982.000362654453
4/17/2014	Pond A5	Leopard Shark	-	864	982.000362654461
4/17/2014	Pond A5	Leopard Shark	-	914	982.000362654494
4/17/2014	Pond A5	Leopard Shark	-	864	982.000362654521
4/17/2014	Pond A5	Leopard Shark	-	889	982.000362654528

4/17/2014	Pond A8	striped bass		737	982.000362654448
4/17/2014	Pond A8	striped bass		762	982.000362654460
4/17/2014	Pond A8	striped bass		660	982.000362654466
4/17/2014	Pond A8	striped bass		787	982.000362654467
4/17/2014	Pond A8	striped bass		330	982.000362655150
4/17/2014	Pond A8	striped bass		762	982.000362654524
4/17/2014	Pond A8	striped bass		965	982.000362654529
4/17/2014	Pond A8	striped bass		305	982.000362654534
4/17/2014	Pond A8	striped bass		305	982.000362654537
4/17/2014	Pond A8	striped bass		838	982.000362654540
4/17/2014	Pond A8	striped bass		508	982.000362654543
10/19/2014	Alamitos Creek	O. mykiss		105	982.000362992262
10/19/2014	Alamitos Creek	O. mykiss		98	982.0003629923
10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992288
10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992271
10/19/2014	Guadalupe Creek	O. mykiss		65	982.000362992351
10/19/2014	Guadalupe Creek	O. mykiss		110	982.000362992281
10/19/2014	Guadalupe Creek	O. mykiss		90	982.000362992331
10/19/2014	Guadalupe Creek	O. mykiss		81	982.000362992285
11/2/2014	Guadalupe Creek	O. mykiss		146	982.000362655573
11/2/2014	Guadalupe Creek	O. mykiss		100	982.000362992305
11/2/2014	Guadalupe Creek	O. mykiss		117	982.000362992280
11/2/2014	Guadalupe Creek	O. mykiss		173	982.000362654463
11/2/2014	Guadalupe Creek	O. mykiss		124	982.000362654546
11/2/2014	Guadalupe Creek	O. mykiss		86	982.000362992307
11/2/2014	Guadalupe Creek	O. mykiss		67	982.000362992342
11/2/2014	Guadalupe Creek	O. mykiss		96	982.000362654480
11/3/2014	Guadalupe Creek	O. mykiss		NA	982.000360826977
11/3/2014	Guadalupe Creek	O. mykiss		93	982.000362992308
11/3/2014	Guadalupe Creek	O. mykiss		85	982.000360826958
11/3/2014	Guadalupe Creek	O. mykiss		72	982.000362992287
11/3/2014	Guadalupe Creek	O. mykiss		123	982.000362655643
11/3/2014	Guadalupe Creek	O. mykiss		120	982.000362655612
11/3/2014	Guadalupe Creek	O. mykiss		78	982.000362992353
11/3/2014	Guadalupe Creek	O. mykiss		139	982.000362655554
11/3/2014	Guadalupe Creek	O. mykiss		168	982.000362655626
11/3/2014	Guadalupe Creek	O. mykiss		72	982.000362992295
11/3/2014	Guadalupe Creek	O. mykiss		65	982.000362992317
11/3/2014	Guadalupe Creek	O. mykiss		88	982.000362992310
9/17/2018	Alamitos Creek	O. mykiss	43.06	146	900.226000319370
9/17/2018	Alamitos Creek	O. mykiss	15.14	111	900.226000319353

9/17/2018	Alamitos Creek	O. mykiss	-	199	900.226000319320
9/17/2018	Alamitos Creek	O. mykiss	17.2	109	900.226000319322
9/17/2018	Alamitos Creek	O. mykiss	13.3	102	900.226000319339
9/17/2018	Alamitos Creek	O. mykiss	15.09	107	900.226000319313
9/17/2018	Alamitos Creek	O. mykiss	8.33	89	900.226000319367
9/17/2018	Alamitos Creek	O. mykiss	-	248	900.226000319355
9/17/2018	Alamitos Creek	O. mykiss	12.92	103	900.226000319350
9/17/2018	Alamitos Creek	O. mykiss	21.42	119	900.226000319366
9/17/2018	Alamitos Creek	O. mykiss	19.34	117	900.226000319375
9/17/2018	Alamitos Creek	O. mykiss	16.51	111	900.226000319326
9/17/2018	Alamitos Creek	O. mykiss	23.78	122	900.226000319387
9/17/2018	Alamitos Creek	O. mykiss	26.74	132	900.226000319376
9/17/2018	Alamitos Creek	O. mykiss	30.42	141	900.226000319319
9/17/2018	Alamitos Creek	O. mykiss	32.1	136	900.226000319352
9/17/2018	Alamitos Creek	O. mykiss	13.3	103	900.226000319314
9/17/2018	Alamitos Creek	O. mykiss	32.7	138	900.226000319391
9/17/2018	Alamitos Creek	O. mykiss	25.26	129	900.226000319310
9/17/2018	Alamitos Creek	O. mykiss	11.5	97	900.226000319372
9/17/2018	Alamitos Creek	O. mykiss	81.27	186	900.226000319301
9/17/2018	Alamitos Creek	O. mykiss	19.01	117	900.226000319384
9/17/2018	Alamitos Creek	O. mykiss	14.39	104	900.226000319316
9/17/2018	Alamitos Creek	O. mykiss	11.97	102	900.226000319397
9/17/2018	Alamitos Creek	O. mykiss	10	95	900.226000319388
9/17/2018	Alamitos Creek	O. mykiss	14.48	106	900.226000319360
9/17/2018	Alamitos Creek	O. mykiss	18.58	115	900.226000319321
9/17/2018	Alamitos Creek	O. mykiss	23.03	122	900.226000319348
10/16/2018	Guadalupe Creek	O. mykiss	7.81	83	900.226000319227
10/16/2018	Guadalupe Creek	O. mykiss	9.25	87	900.226000319276
10/16/2018	Guadalupe Creek	O. mykiss	14.28	106	900.226000319293
10/16/2018	Guadalupe Creek	O. mykiss	4.75	67	900.226000319318
10/16/2018	Guadalupe Creek	O. mykiss	4.62	72	900.226000319305
10/16/2018	Guadalupe Creek	O. mykiss	3.72	66	900.226000319334
10/16/2018	Guadalupe Creek	O. mykiss	6.37	72	900.226000319341
10/16/2018	Guadalupe Creek	O. mykiss	3.58	65	900.226000319308
10/16/2018	Guadalupe Creek	O. mykiss	31.33	138	900.226000319389
10/16/2018	Guadalupe Creek	O. mykiss	6.82	81	900.226000319385
10/16/2018	Guadalupe Creek	O. mykiss	4.58	66	900.226000319338
10/16/2018	Guadalupe Creek	O. mykiss	5.32	74	900.226000319324
10/16/2018	Guadalupe Creek	O. mykiss	6.93	86	900.226000319364
10/16/2018	Guadalupe Creek	O. mykiss	6.66	79	900.226000319345
10/16/2018	Guadalupe Creek	O. mykiss	8.33	84	900.226000319358

10/16/2018	Guadalupe Creek	O. mykiss	6.12	76	900.226000319329
10/16/2018	Guadalupe Creek	O. mykiss	4.97	70	900.226000319351
10/17/2018	Guadalupe Creek	O. mykiss	5.62	75	900.226000319346
10/17/2018	Guadalupe Creek	O. mykiss	4.22	66	900.226000319394
10/17/2018	Guadalupe Creek	O. mykiss	6.02	79	900.226000319386
10/17/2018	Guadalupe Creek	O. mykiss	5.9	77	900.226000319340
10/17/2018	Guadalupe Creek	O. mykiss	4.52	70	900.226000319317
10/17/2018	Guadalupe Creek	O. mykiss	5.14	72	900.226000319337
10/17/2018	Guadalupe Creek	O. mykiss	8.05	86	900.226000319344
10/17/2018	Guadalupe Creek	O. mykiss	4.23	68	900.226000319330
10/17/2018	Guadalupe Creek	O. mykiss	6.06	75	900.226000319307
10/17/2018	Guadalupe Creek	O. mykiss	4.08	67	900.226000319309
10/17/2018	Guadalupe Creek	O. mykiss	3.83	65	900.226000319333
10/17/2018	Guadalupe Creek	O. mykiss	5.66	74	900.226000319361
10/17/2018	Guadalupe Creek	O. mykiss	96.04	199	900.228000613702
10/17/2018	Guadalupe Creek	O. mykiss	4.61	65	900.226000319381
10/17/2018	Guadalupe Creek	O. mykiss	6.62	76	900.226000319342
10/17/2018	Guadalupe Creek	O. mykiss	4.35	66	900.226000319399
10/17/2018	Guadalupe Creek	O. mykiss	4.63	70	900.226000319377
10/17/2018	Guadalupe Creek	O. mykiss	5.68	72	900.226000319371
10/17/2018	Guadalupe Creek	O. mykiss	6.23	75	900.226000319395
10/17/2018	Guadalupe Creek	O. mykiss	4.95	69	900.226000319325
10/17/2018	Guadalupe Creek	O. mykiss	6.2	78	900.226000319356
10/17/2018	Guadalupe Creek	O. mykiss	6.22	79	900.226000319374
10/17/2018	Guadalupe Creek	O. mykiss	4.36	69	900.226000319379
10/17/2018	Guadalupe Creek	O. mykiss	4.53	67	900.226000319354
10/17/2018	Guadalupe Creek	O. mykiss	18.15	112	900.226000319328
10/17/2018	Guadalupe Creek	O. mykiss	3.85	68	900.226000319393
10/17/2018	Guadalupe Creek	O. mykiss	5.05	79	900.226000319327
10/17/2018	Guadalupe Creek	O. mykiss	5.23	74	900.226000319362
10/17/2018	Guadalupe Creek	O. mykiss	11.22	90	900.226000319304
10/17/2018	Guadalupe Creek	O. mykiss	5.31	74	900.226000319398
10/18/2018	Alamitos Creek	O. mykiss	5.35	68	900.226000319284
10/18/2018	Alamitos Creek	O. mykiss	4.23	66	900.226000319260
10/18/2018	Alamitos Creek	O. mykiss	4.35	65	900.226000319291
10/18/2018	Alamitos Creek	O. mykiss	3.25	65	900.226000319292
10/18/2018	Alamitos Creek	O. mykiss	4.86	69	900.226000319295
10/18/2018	Alamitos Creek	O. mykiss	20.6	125	900.226000319250
10/18/2018	Alamitos Creek	O. mykiss	17.5	109	900.226000319246
10/18/2018	Alamitos Creek	O. mykiss	36.5	145	900.226000319258
10/18/2018	Alamitos Creek	O. mykiss	14.8	79	900.226000319263

10/18/2018	Alamitos Creek	O. mykiss	24.9	109	900.226000319201
10/18/2018	Alamitos Creek	O. mykiss	12.5	94	900.226000319218
10/18/2018	Alamitos Creek	O. mykiss	18.6	106	900.226000319269
10/18/2018	Alamitos Creek	O. mykiss	20.2	111	900.226000319200
10/18/2018	Alamitos Creek	O. mykiss	19	108	900.226000319311
10/18/2018	Alamitos Creek	O. mykiss	42.3	146	900.226000319257
10/18/2018	Alamitos Creek	O. mykiss	16.8	110	900.226000319290
10/22/2018	Alamitos Creek	O. mykiss	7.7	84	900.226000319343
10/22/2018	Alamitos Creek	O. mykiss	13.8	98	900.226000319306
10/22/2018	Alamitos Creek	O. mykiss	13	100	900.226000319349
10/22/2018	Alamitos Creek	O. mykiss	9.6	91	900.226000319312
10/22/2018	Alamitos Creek	O. mykiss	14.1	102	900.226000319315
10/22/2018	Alamitos Creek	O. mykiss	12.8	103	900.226000319382
10/22/2018	Alamitos Creek	O. mykiss	10	91	900.226000319365
10/22/2018	Alamitos Creek	O. mykiss	445	345	900.228000613703
10/22/2018	Alamitos Creek	O. mykiss	9.4	92	900.226000319363
10/22/2018	Alamitos Creek	O. mykiss	10.2	90	900.226000319390
10/22/2018	Alamitos Creek	O. mykiss	23	119	900.226000319378
10/22/2018	Alamitos Creek	O. mykiss	25.1	115	900.226000319396
10/22/2018	Alamitos Creek	O. mykiss	20.8	117	900.226000319368
10/22/2018	Alamitos Creek	O. mykiss	28.2	129	900.226000319380
10/23/2018	Calero Creek	O. mykiss	215.3	263	900.228000613704
10/23/2018	Calero Creek	O. mykiss	7.5	82	900.226000319280
10/23/2018	Calero Creek	O. mykiss	125.2	216	900.228000613705
10/23/2018	Calero Creek	O. mykiss	14.3	109	900.226000319268
10/23/2018	Calero Creek	O. mykiss	11.5	95	900.226000319336
10/23/2018	Calero Creek	O. mykiss	7.3	82	900.226000319302
10/23/2018	Calero Creek	O. mykiss	10.1	89	900.226000319332
10/23/2018	Calero Creek	O. mykiss	5.2	67	900.226000319373
10/24/2018	Calero Creek	O. mykiss	9.3	84	900.226000319357
10/24/2018	Calero Creek	O. mykiss	7.8	84	900.226000319347
10/24/2018	Calero Creek	O. mykiss	5.4	75	900.226000319323
10/24/2018	Calero Creek	O. mykiss	10.4	86	900.226000319300
10/24/2018	Calero Creek	O. mykiss	8.5	85	900.226000319231
10/24/2018	Calero Creek	O. mykiss	12.5	94	900.226000319244
10/24/2018	Calero Creek	O. mykiss	8.3	82	900.226000319287
10/24/2018	Calero Creek	O. mykiss	10.2	93	900.226000319230
10/24/2018	Calero Creek	O. mykiss	9.4	86	900.226000319212
11/6/2018	Guadalupe Creek	O. mykiss	12.4	95	900.226000319294
11/6/2018	Guadalupe Creek	O. mykiss	8.7	87	900.226000319214
11/6/2018	Guadalupe Creek	O. mykiss	18.2	116	900.226000319278

10/9/2019	Guadalupe Creek	O. mykiss	5.73	75	900.228000613710
10/9/2019	Guadalupe Creek	O. mykiss	6.6	84	900.226000319233
10/9/2019	Guadalupe Creek	O. mykiss	9.5	88	900.226000319239
10/9/2019	Guadalupe Creek	O. mykiss	7.1	81	900.226000319210
10/9/2019	Guadalupe Creek	O. mykiss	152.1	234	900.228000613711
10/9/2019	Guadalupe Creek	O. mykiss	5.1	71	900.226000319209
10/9/2019	Guadalupe Creek	O. mykiss	5.8	77	900.226000319277
10/9/2019	Guadalupe Creek	O. mykiss	9.6	85	900.226000319220
10/9/2019	Guadalupe Creek	O. mykiss	53.6	168	900.228000613712
10/9/2019	Guadalupe Creek	O. mykiss	14.7	104	900.226000319222
10/9/2019	Guadalupe Creek	O. mykiss	8.6	84	900.226000319228
10/9/2019	Guadalupe Creek	O. mykiss	8.0	76	900.226000319237
10/10/2019	Alamitos Creek	O. mykiss	11.4	95	900.226000319265
10/10/2019	Guadalupe Creek	O. mykiss	8.6	82	900.226000319288
10/10/2019	Guadalupe Creek	O. mykiss	8.6	86	900.226000319208
10/10/2019	Guadalupe Creek	O. mykiss	9.4	89	900.226000319252
10/10/2019	Guadalupe Creek	O. mykiss	3.4	66	900.226000319369
10/10/2019	Guadalupe Creek	O. mykiss	7.9	85	900.226000319249
10/10/2019	Guadalupe Creek	O. mykiss	41.7	150	900.226000319215
10/10/2019	Guadalupe Creek	O. mykiss	16.3	106	900.226000319204
10/10/2019	Guadalupe Creek	O. mykiss	6.5	82	900.226000319296
10/10/2019	Guadalupe Creek	O. mykiss	14.3	99	900.226000319261
10/10/2019	Guadalupe Creek	O. mykiss	7.1	81	900.226000319206
10/10/2019	Guadalupe Creek	O. mykiss	10.2	91	900.226000319242
10/10/2019	Guadalupe Creek	O. mykiss	7.7	81	900.226000319219
10/10/2019	Guadalupe Creek	O. mykiss	9.5	89	900.226000319216
10/10/2019	Guadalupe Creek	O. mykiss	10.4	91	900.226000319281
10/10/2019	Guadalupe Creek	O. mykiss	12.3	100	900.226000319217
10/10/2019	Guadalupe Creek	O. mykiss	16.5	107	900.226000319272
10/10/2019	Guadalupe Creek	O. mykiss	13.4	104	900.226000319247
10/23/2019	Alamitos Creek	O. mykiss	7.9	83	900.226000319254
10/23/2019	Alamitos Creek	O. mykiss	11.5	87	900.226000319203
10/23/2019	Alamitos Creek	O. mykiss	5.5	75	900.226000319205
10/23/2019	Alamitos Creek	O. mykiss	3.3	65	900.226000319225
10/23/2019	Alamitos Creek	O. mykiss	3.9	68	900.226000319282
10/23/2019	Alamitos Creek	O. mykiss	4.9	71	900.226000319224
10/23/2019	Alamitos Creek	O. mykiss	5.7	76	900.226000319248
10/23/2019	Alamitos Creek	O. mykiss	13.9	105	900.226000319221
10/23/2019	Alamitos Creek	O. mykiss	5.3	72	900.226000319226
10/23/2019	Alamitos Creek	O. mykiss	4.1	68	900.226000319202
10/23/2019	Alamitos Creek	O. mykiss	4.8	69	900.226000319223

10/23/2019	Alamitos Creek	O. mykiss	14.4	105	900.226000319236
10/23/2019	Alamitos Creek	O. mykiss	4.7	67	900.226000319240
10/23/2019	Alamitos Creek	O. mykiss	22.9	122	900.226000319274
10/23/2019	Alamitos Creek	O. mykiss	5.2	73	900.226000319283
10/23/2019	Alamitos Creek	O. mykiss	10.7	90	900.226000319273
10/23/2019	Alamitos Creek	O. mykiss	15.1	106	900.226000319256
10/23/2019	Alamitos Creek	O. mykiss	9.0	88	900.226000319211
10/28/2019	Calero Creek	O. mykiss	250.1	280	900.228000613713
10/28/2019	Calero Creek	O. mykiss	7.9	85	900.226000319259
10/28/2019	Calero Creek	O. mykiss	6.6	81	900.226000319297
10/28/2019	Calero Creek	O. mykiss	12.4	96	900.226000319285
10/28/2019	Calero Creek	O. mykiss	14.6	107	900.226000319286
10/28/2019	Calero Creek	O. mykiss	12.3	95	900.226000319207
10/28/2019	Calero Creek	O. mykiss	8.5	86	900.226000319245
10/30/2019	Guadalupe River	O. mykiss	169.6	248	900.228000613714
10/31/2019	Alamitos Creek	O. mykiss	7.0	81	900.226000319270
10/31/2019	Alamitos Creek	O. mykiss	12.2	99	900.226000319232
10/31/2019	Alamitos Creek	O. mykiss	28.8	134	900.226000319213
10/31/2019	Alamitos Creek	O. mykiss	11.7	95	900.226000319241
10/31/2019	Alamitos Creek	O. mykiss	5.8	75	900.226000319267
10/31/2019	Alamitos Creek	O. mykiss	10.7	90	900.226000319298
10/31/2019	Alamitos Creek	O. mykiss	6.3	76	900.226000319299
10/31/2019	Alamitos Creek	O. mykiss	13.4	98	900.226000319234
10/31/2019	Alamitos Creek	O. mykiss	11.6	93	900.226000319271
10/31/2019	Alamitos Creek	O. mykiss	11.5	95	900.226000319238
10/31/2019	Alamitos Creek	O. mykiss	11.9	99	900.226000319255
10/31/2019	Alamitos Creek	O. mykiss	8.5	90	900.226000319251
10/31/2019	Alamitos Creek	O. mykiss	15.9	103	900.226000319262
10/31/2019	Alamitos Creek	O. mykiss	25.4	130	900.226000319253
10/31/2019	Alamitos Creek	O. mykiss	12.0	96	900.226000319229
10/31/2019	Alamitos Creek	O. mykiss	14.1	97	900.226000319275
10/31/2019	Alamitos Creek	O. mykiss	20.2	115	900.226000319279
10/31/2019	Alamitos Creek	O. mykiss	33.6	140	982.126058146080
10/31/2019	Alamitos Creek	O. mykiss	18.9	112	982.126058146069
10/31/2019	Alamitos Creek	O. mykiss	19.5	117	982.126058146081
10/31/2019	Alamitos Creek	O. mykiss	15.1	105	982.126058146089
10/31/2019	Alamitos Creek	O. mykiss	6.6	80	982.126058146053
10/31/2019	Alamitos Creek	O. mykiss	65.4	173	900.228000613716
10/31/2019	Alamitos Creek	O. mykiss	281.8	280	900.228000613715
10/31/2019	Alamitos Creek	O. mykiss	60.3	170	900.228000613718
10/31/2019	Alamitos Creek	O. mykiss	40.1	150	900.228000613717

11/4/2019	Upper Penitencia	O. mykiss	5.2	74	982.126058146054
11/4/2019	Upper Penitencia	O. mykiss	6.0	76	982.126058146126
11/4/2019	Upper Penitencia	O. mykiss	7.0	79	982.126058146101
11/4/2019	Upper Penitencia	O. mykiss	9.3	89	982.126058146077
11/4/2019	Upper Penitencia	O. mykiss	75.1	189	900.228000613719
11/4/2019	Upper Penitencia	O. mykiss	17.8	111	982.126058146117
11/4/2019	Upper Penitencia	O. mykiss	15.1	108	982.126058146065
11/4/2019	Upper Penitencia	O. mykiss	9.9	94	982.126058146106
11/4/2019	Upper Penitencia	O. mykiss	9.1	88	982.126058146036
11/4/2019	Upper Penitencia	O. mykiss	96.5	209	900.228000613720
11/4/2019	Upper Penitencia	O. mykiss	151.3	236	900.228000613721
11/4/2019	Upper Penitencia	O. mykiss	-	-	900.228000613722
11/4/2019	Upper Penitencia	O. mykiss	12.4	97	982.126058146093
11/4/2019	Upper Penitencia	O. mykiss	7.8	85	982.126058146039
11/4/2019	Upper Penitencia	O. mykiss	11.3	93	982.126058146070
11/4/2019	Upper Penitencia	O. mykiss	63.9	177	900.228000613723
11/4/2019	Upper Penitencia	O. mykiss	5.1	74	982.126058146083
11/4/2019	Upper Penitencia	O. mykiss	59.4	178	900.228000613724
11/4/2019	Upper Penitencia	O. mykiss	13.8	105	982.126058146067
11/4/2019	Upper Penitencia	O. mykiss	8.5	84	982.126058146084
11/4/2019	Upper Penitencia	O. mykiss	-	79	982.126058146042
11/4/2019	Upper Penitencia	O. mykiss	24.1	130	982.126058146043
11/4/2019	Upper Penitencia	O. mykiss	-	106	982.126058146105
11/4/2019	Upper Penitencia	O. mykiss	12	92	982.126058146111
11/4/2019	Upper Penitencia	O. mykiss	4.5	73	982.126058146044
11/4/2019	Upper Penitencia	O. mykiss	7.6	84	982.126058146100
11/4/2019	Upper Penitencia	O. mykiss	17.3	108	982.126058146116
11/4/2019	Upper Penitencia	O. mykiss	48.2	162	900.228000613726
11/4/2019	Upper Penitencia	O. mykiss	10.8	92	982.126058146058
11/4/2019	Upper Penitencia	O. mykiss	41.1	158	900.228000613727
11/4/2019	Upper Penitencia	O. mykiss	8.7	91	982.126058146085
11/4/2019	Upper Penitencia	O. mykiss	5.2	73	982.126058146095
11/4/2019	Upper Penitencia	O. mykiss	7.2	85	982.126058146103
11/4/2019	Upper Penitencia	O. mykiss	15.5	103	982.126058146046
11/4/2019	Upper Penitencia	O. mykiss	10.7	100	982.126058146074
11/4/2019	Upper Penitencia	O. mykiss	5.8	78	982.126058146076
11/4/2019	Upper Penitencia	O. mykiss	41.9	156	900.228000613728
11/4/2019	Upper Penitencia	O. mykiss	38.6	145	982.126058146034
11/4/2019	Upper Penitencia	O. mykiss	49.2	162	900.228000613730
11/4/2019	Upper Penitencia	O. mykiss	12.5	101	982.126058146096
11/4/2019	Upper Penitencia	O. mykiss	6.2	78	982.126058146055

11/4/2019	Upper Penitencia	O. mykiss	13.3	96	982.126058146033
11/4/2019	Upper Penitencia	O. mykiss	8.7	88	982.126058146037
11/4/2019	Upper Penitencia	O. mykiss	6.9	83	982.126058146063
11/4/2019	Upper Penitencia	O. mykiss	13.1	102	982.126058146071
11/4/2019	Upper Penitencia	O. mykiss	143.1	234	900.228000613729
11/4/2019	Upper Penitencia	O. mykiss	5.8	75	982.126058146129
11/4/2019	Upper Penitencia	O. mykiss	19.7	112	982.126058146064
11/4/2019	Upper Penitencia	O. mykiss	55.3	172	900.228000613731
11/4/2019	Upper Penitencia	O. mykiss	11.5	98	982.126058146079
11/4/2019	Upper Penitencia	O. mykiss	19.2	112	982.126058146068
11/4/2019	Upper Penitencia	O. mykiss	6.2	79	982.126058146092
11/4/2019	Upper Penitencia	O. mykiss	7.9	86	982.126058146056
11/4/2019	Upper Penitencia	O. mykiss	5.3	77	982.126058146087
11/4/2019	Upper Penitencia	O. mykiss	6.3	81	982.126058146048
11/4/2019	Upper Penitencia	O. mykiss	8.7	90	982.126058146062
11/4/2019	Upper Penitencia	O. mykiss	6.3	78	982.126058146041
11/4/2019	Upper Penitencia	O. mykiss	13.9	101	982.126058146098
11/4/2019	Upper Penitencia	O. mykiss	5.5	77	982.126058146113
11/4/2019	Upper Penitencia	O. mykiss	5.1	74	982.126058146115
11/4/2019	Upper Penitencia	O. mykiss	8.6	90	982.126058146088
11/4/2019	Upper Penitencia	O. mykiss	171.5	245	900.228000613732
11/6/2019	Coyote Creek	O. mykiss	18.1	112	982.126058146078
11/6/2019	Coyote Creek	O. mykiss	23.2	122	982.126058146114
11/6/2019	Coyote Creek	O. mykiss	28.2	133	982.126058146107
11/13/2019	Upper Penitencia	O. mykiss	31.8	141	982.126058146110
11/13/2019	Upper Penitencia	O. mykiss	10.6	95	982.126058146131
11/13/2019	Upper Penitencia	O. mykiss	38.8	153	900.228000613734
11/13/2019	Upper Penitencia	O. mykiss	24.8	128	982.126058146118
11/13/2019	Upper Penitencia	O. mykiss	20.4	125	982.126058146082
11/13/2019	Upper Penitencia	O. mykiss	58.2	172	900.228000613735
11/13/2019	Upper Penitencia	O. mykiss	54.7	168	900.228000613736
11/13/2019	Upper Penitencia	O. mykiss	35.2	149	982.126058146075
11/13/2019	Upper Penitencia	O. mykiss	147.8	238	900.228000613738
11/13/2019	Upper Penitencia	O. mykiss	46.3	159	900.228000613739
11/13/2019	Upper Penitencia	O. mykiss	23.5	124	982.126058146102
11/13/2019	Upper Penitencia	O. mykiss	96.5	204	900.228000613737
11/13/2019	Upper Penitencia	O. mykiss	68.9	184	900.228000613740
11/13/2019	Upper Penitencia	O. mykiss	119.5	224	900.228000613742
11/13/2019	Upper Penitencia	O. mykiss	7.5	84	982.126058146051
11/13/2019	Upper Penitencia	O. mykiss	7.5	86	982.126058146038
11/13/2019	Upper Penitencia	O. mykiss	30.5	140	982.126058146123

11/13/2019	Upper Penitencia	O. mykiss	9.8	88	982.126058146057
11/13/2019	Upper Penitencia	O. mykiss	12.2	97	982.126058146032
11/13/2019	Upper Penitencia	O. mykiss	8.7	80	982.126058146073
11/13/2019	Upper Penitencia	O. mykiss	23.6	125	982.126058146047
11/13/2019	Upper Penitencia	O. mykiss	15.7	94	982.126058146122
11/13/2019	Upper Penitencia	O. mykiss	13.8	94	982.126058146049
11/13/2019	Upper Penitencia	O. mykiss	9.1	86	982.126058146109
11/13/2019	Upper Penitencia	O. mykiss	8.8	84	982.126058146052
11/13/2019	Upper Penitencia	O. mykiss	24.5	124	982.126058146099
11/13/2019	Upper Penitencia	O. mykiss	26.3	128	982.126058146128
11/13/2019	Upper Penitencia	O. mykiss	73.5	184	900.228000613743
11/13/2019	Upper Penitencia	O. mykiss	38.5	134	982.126058146124
11/13/2019	Upper Penitencia	O. mykiss	2.9	84	982.126058146045
11/13/2019	Upper Penitencia	O. mykiss	110.3	209	900.228000613744
11/13/2019	Upper Penitencia	O. mykiss	28.9	132	982.126058146108
11/13/2019	Upper Penitencia	O. mykiss	12.4	96	982.126058146090
11/13/2019	Upper Penitencia	O. mykiss	37.2	154	982.126058146059
8/4/2020	Upper Penitencia Creek	O. mykiss	38.2	147	982.126058146943
8/4/2020	Upper Penitencia Creek	O. mykiss		144	982.126058146121
8/4/2020	Upper Penitencia Creek	O. mykiss	25.4	129	982.126058146947
8/4/2020	Upper Penitencia Creek	O. mykiss	22.2	121	982.126058146948
8/4/2020	Upper Penitencia Creek	O. mykiss	39.3	152	900.228000613803
8/4/2020	Upper Penitencia Creek	O. mykiss	59.1	178	900.228000613802
8/4/2020	Upper Penitencia Creek	O. mykiss	124	237	900.228000613804
8/4/2020	Upper Penitencia Creek	O. mykiss	31.5	142	982.126058146963
8/4/2020	Upper Penitencia Creek	O. mykiss	36.1	151	900.228000613801
8/4/2020	Upper Penitencia Creek	O. mykiss	79.4	196	900.228000613806
8/4/2020	Upper Penitencia Creek	O. mykiss		104	982.126058146086
8/4/2020	Upper Penitencia Creek	O. mykiss	26.4	130	982.126058146954
8/4/2020	Upper Penitencia Creek	O. mykiss		123	982.126058146066
10/21/2020	Guadalupe Creek	O. mykiss	3.9	67	982.126058146127
10/21/2020	Guadalupe Creek	O. mykiss	6.4	78	982.126058146094
10/21/2020	Guadalupe Creek	O. mykiss	4.1	71	982.126058146060
10/21/2020	Guadalupe Creek	O. mykiss	59.7	184	900.228000613747
10/21/2020	Guadalupe Creek	O. mykiss	5.8	82	982.126058146130
10/21/2020	Guadalupe Creek	O. mykiss	8.1	83	982.126058146119
10/21/2020	Guadalupe Creek	O. mykiss	10.5	97	982.126058146050
10/21/2020	Guadalupe Creek	O. mykiss	17.5	118	982.126058146061
10/21/2020	Guadalupe Creek	O. mykiss	11.2	99	982.126058146104
10/22/2020	Guadalupe Creek	O. mykiss	4.5	71	982.126058146072
10/28/2020	Stevens Creek	O. mykiss	21	122	982.126058146870

10/28/2020	Stevens Creek	O. mykiss	15.1	105	982.126058146097
10/28/2020	Stevens Creek	O. mykiss	24.2	125	982.126058146872
10/28/2020	Stevens Creek	O. mykiss	34.5	146	982.126058146923
10/28/2020	Stevens Creek	O. mykiss	4.4	68	982.126058146881
10/28/2020	Stevens Creek	O. mykiss	15.6	103	982.126058146902
10/28/2020	Stevens Creek	O. mykiss	48.5	162	900.228000613748
10/28/2020	Stevens Creek	O. mykiss	4.8	70	982.126058146867
10/28/2020	Stevens Creek	O. mykiss	3.8	69	982.126058146909
10/28/2020	Stevens Creek	O. mykiss	4.3	69	982.126058146926
10/28/2020	Stevens Creek	O. mykiss	4.5	69	982.126058146911
10/29/2020	Stevens Creek	O. mykiss	4.6	66	982.126058146903
10/29/2020	Stevens Creek	O. mykiss	4.8	69	982.126058146908
10/29/2020	Stevens Creek	O. mykiss	3.9	68	982.126058146927
10/29/2020	Stevens Creek	O. mykiss	4.1	68	982.126058146919
10/29/2020	Stevens Creek	O. mykiss	3.3	67	982.126058146891
10/29/2020	Stevens Creek	O. mykiss	5.1	71	982.126058146913
10/29/2020	Stevens Creek	O. mykiss	6.1	75	982.126058146914
10/29/2020	Stevens Creek	O. mykiss	4.4	71	982.126058146892
10/29/2020	Stevens Creek	O. mykiss	4.5	69	982.126058146890
10/29/2020	Stevens Creek	O. mykiss	4.4	69	982.126058146861
10/29/2020	Stevens Creek	O. mykiss	6.6	78	982.126058146875
10/29/2020	Stevens Creek	O. mykiss	6.2	78	982.126058146920
10/29/2020	Stevens Creek	O. mykiss	13.1	100	982.126058146874
10/29/2020	Stevens Creek	O. mykiss	4.3	65	982.126058146899
10/29/2020	Stevens Creek	O. mykiss	34.6	141	982.126058146900
10/29/2020	Stevens Creek	O. mykiss	4.2	72	982.126058146858
10/29/2020	Stevens Creek	O. mykiss	8.6	82	982.126058146924
10/29/2020	Stevens Creek	O. mykiss	9.5	88	982.126058146888
10/29/2020	Stevens Creek	O. mykiss	4.9	74	982.126058146922
10/29/2020	Stevens Creek	O. mykiss	4.9	71	982.126058146931
10/29/2020	Stevens Creek	O. mykiss	4.2	70	982.126058146918
10/29/2020	Stevens Creek	O. mykiss	4.4	67	982.126058146925
10/29/2020	Stevens Creek	O. mykiss	4.8	70	982.126058146886
10/29/2020	Stevens Creek	O. mykiss	4.4	71	982.126058146897
10/29/2020	Stevens Creek	O. mykiss	5	71	982.126058146921
10/29/2020	Stevens Creek	O. mykiss	3.7	69	982.126058146928
11/2/2020	Calero Creek	O. mykiss	5.2	74	982.126058146917
11/2/2020	Calero Creek	O. mykiss	7.4	86	982.126058146847
11/2/2020	Calero Creek	O. mykiss	3.7	66	982.126058146876
11/2/2020	Calero Creek	O. mykiss	3.8	68	982.126058146850
11/2/2020	Calero Creek	O. mykiss	8.9	87	982.126058146869

11/2/2020	Calero Creek	O. mykiss	5.1	70	982.126058146859
11/2/2020	Calero Creek	O. mykiss	2.9	66	982.126058146894
11/2/2020	Calero Creek	O. mykiss	5.8	81	982.126058146841
11/2/2020	Calero Creek	O. mykiss	6.2	76	982.1.6058146889
11/2/2020	Calero Creek	O. mykiss	12.9	99	982.126058146860
11/2/2020	Calero Creek	O. mykiss	7.6	86	982.126058146849
11/2/2020	Calero Creek	O. mykiss	4.9	72	982.126058146856
11/2/2020	Calero Creek	O. mykiss	6.5	81	982.126058146845
11/2/2020	Calero Creek	O. mykiss	7.1	84	982.126058146904
11/2/2020	Calero Creek	O. mykiss	11.3	97	982.126058146834
11/2/2020	Calero Creek	O. mykiss	4.6	73	982.126058146863
11/2/2020	Calero Creek	O. mykiss	9.1	90	982.126058146901
11/2/2020	Calero Creek	O. mykiss	11	96	982.126058146896
11/2/2020	Calero Creek	O. mykiss	295.5	290	900.228000613749
11/2/2020	Calero Creek	O. mykiss	3.6	66	982.126058146910
11/2/2020	Calero Creek	O. mykiss	3.9	67	982.126058146871
11/2/2020	Calero Creek	O. mykiss	5.3	75	982.126058146912
11/2/2020	Calero Creek	O. mykiss	4.1	71	982.126058146893
11/2/2020	Calero Creek	O. mykiss	6.7	82	982.126058146833
11/2/2020	Calero Creek	O. mykiss	4.8	71	982.126058146906
11/2/2020	Calero Creek	O. mykiss	4	70	982.126058146915
11/2/2020	Calero Creek	O. mykiss	7.2	81	982.126058146930
11/2/2020	Calero Creek	O. mykiss	8.5	88	982.126058146862
11/2/2020	Calero Creek	O. mykiss	5.7	73	982.126058146884
11/2/2020	Calero Creek	O. mykiss	5.5	79	982.126058146887
11/9/2020	Alamitos Creek	O. mykiss	157.8	239	900.228000613750
11/9/2020	Alamitos Creek	O. mykiss	26.1	133	982.126058146864
11/9/2020	Alamitos Creek	O. mykiss	14.6	94	982.126058146879
11/9/2020	Alamitos Creek	O. mykiss	16.5	103	982.126058146898
11/9/2020	Alamitos Creek	O. mykiss	19.4	106	982.126058146873
11/9/2020	Alamitos Creek	O. mykiss	16.2	111	982.126058146851
11/9/2020	Alamitos Creek	O. mykiss	162.5	240	900.228000613752
11/9/2020	Alamitos Creek	O. mykiss	80	192	900.228000613751
11/9/2020	Alamitos Creek	O. mykiss	25.8	125	982.126058146929
11/9/2020	Alamitos Creek	O. mykiss	27.8	138	982.126058146854
11/9/2020	Alamitos Creek	O. mykiss	9.8	95	982.126058146857
11/10/2020	Alamitos Creek	O. mykiss	19.7	123	982.126058146838
11/10/2020	Alamitos Creek	O. mykiss	6.6	79	982.126058146832
11/10/2020	Alamitos Creek	O. mykiss	15.4	117	982.126058146916
11/10/2020	Alamitos Creek	O. mykiss	23.1	132	982.126058146852
11/10/2020	Alamitos Creek	O. mykiss	25.9	136	982.126058146868

11/12/2020	Alamitos Creek	O. mykiss	29.7	135	982.126058146853
11/12/2020	Alamitos Creek	O. mykiss	23.7	129	982.126058146839
11/12/2020	Alamitos Creek	O. mykiss	9.8	90	982.126058146843
11/12/2020	Alamitos Creek	O. mykiss	20.1	113	982.126058146877
11/12/2020	Alamitos Creek	O. mykiss	31.5	133	982.126058146836
11/12/2020	Alamitos Creek	O. mykiss	18.4	110	982.126058146878
11/18/2020	Guadalupe Creek	O. mykiss	28.4	145	982.126058146882
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10/18/2021	Calero Creek	O. mykiss	9.4	85	982.126059706529
10/18/2021	Calero Creek	O. mykiss	6.1	77	982.126059709101
10/18/2021	Calero Creek	O. mykiss	4.6	66	982.126059706512
10/18/2021	Calero Creek	O. mykiss	6.9	74	982.126059709081
10/18/2021	Calero Creek	O. mykiss	4.9	71	982.126059709092
10/18/2021	Calero Creek	O. mykiss	6.8	79	982.126059706527
10/18/2021	Calero Creek	O. mykiss	81.5	182	900.228000613810
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10/18/2021	Calero Creek	O. mykiss	3.4	65	982.126059706553
10/18/2021	Calero Creek	O. mykiss	4.3	69	982.126059706549
10/18/2021	Calero Creek	O. mykiss	3.8	68	982.126059706576
10/18/2021	Calero Creek	O. mykiss	3.6	65	982.126059706577
10/18/2021	Calero Creek	O. mykiss	5.8	74	982.126059706533
10/18/2021	Calero Creek	O. mykiss	7.7	78	982.126059709102
10/18/2021	Calero Creek	O. mykiss	5.7	74	982.126059706523
10/18/2021	Calero Creek	O. mykiss	10.9	89	982.126059709078
10/18/2021	Calero Creek	O. mykiss	7.8	84	982.126059709103
10/18/2021	Calero Creek	O. mykiss	7.5	84	982.126059706551
10/18/2021	Calero Creek	O. mykiss	8.4	85	982.126059709108
10/18/2021	Calero Creek	O. mykiss	5.4	72	982.126059706561
10/18/2021	Calero Creek	O. mykiss	5.1	70	982.126059706544
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10/28/2021	Alamitos Creek	O. mykiss	5.1	75	982.126059706552
10/29/2021	Alamitos Creek	O. mykiss	5	75	982.126059706554
10/29/2021	Alamitos Creek	O. mykiss	8.2	84	982.126059709079
11/1/2021	Coyote Creek	O. mykiss	117.9	209	900.228000613753
11/1/2021	Coyote Creek	O. mykiss	43.4	151	900.228000613754
11/1/2021	Coyote Creek	O. mykiss	25.2	126	982.126059706573
11/1/2021	Coyote Creek	O. mykiss	11.9	101	982.126059706540
11/1/2021	Coyote Creek	O. mykiss	13.7	99	982.126059706520
11/1/2021	Coyote Creek	O. mykiss	11.4	97	982.126059706563
11/1/2021	Coyote Creek	O. mykiss	8.9	86	982.126059709085

11/2/2021	Coyote Creek	O. mykiss	30.4	139	982.126059706568
11/2/2021	Coyote Creek	O. mykiss	24.2	129	982.126059709100
11/2/2021	Coyote Creek	O. mykiss	28.7	132	982.126059706511
11/2/2021	Coyote Creek	O. mykiss	17.5	115	982.126059706557
11/2/2021	Coyote Creek	O. mykiss	26.9	129	982.126059709087
11/2/2021	Coyote Creek	O. mykiss	26.7	124	982.126059706516
11/2/2021	Coyote Creek	O. mykiss	21.7	119	982.126059706567
11/2/2021	Coyote Creek	O. mykiss	9.3	95	982.126059706513
11/2/2021	Coyote Creek	O. mykiss	5.2	80	982.126059706555
11/2/2021	Coyote Creek	O. mykiss	21.1	119	982.126059706569
11/2/2021	Coyote Creek	O. mykiss	12.8	98	982.126059706538
11/2/2021	Coyote Creek	O. mykiss	16.3	105	982.126059706550
11/2/2021	Coyote Creek	O. mykiss	21.4	118	982.126059709095
11/2/2021	Coyote Creek	O. mykiss	19.8	110	982.126059706560
11/2/2021	Coyote Creek	O. mykiss	27.1	125	982.126059709089
11/2/2021	Coyote Creek	O. mykiss	18.5	113	982.126059709083
11/2/2021	Coyote Creek	O. mykiss	23.1	125	982.126059709096
11/3/2021	Coyote Creek	O. mykiss	28.4	131	982.126059706537
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11/3/2021	Coyote Creek	O. mykiss	36.9	147	982.126059709106
11/3/2021	Coyote Creek	O. mykiss	32.5	141	982.126059706564
11/3/2021	Coyote Creek	O. mykiss	17.5	116	982.126059706519
11/3/2021	Coyote Creek	O. mykiss	11.9	99	982.126059706562
11/3/2021	Coyote Creek	O. mykiss	37.8	148	982.126059706545
11/3/2021	Coyote Creek	O. mykiss	28.0	134	982.126059709084
11/3/2021	Coyote Creek	O. mykiss	15.4	103	982.126059706572
11/3/2021	Coyote Creek	O. mykiss	17.3	112	982.126059709098
11/3/2021	Coyote Creek	O. mykiss	28.4	132	982.126059709093
11/3/2021	Coyote Creek	O. mykiss	29.5	135	982.126059706547
11/3/2021	Coyote Creek	O. mykiss	43.7	150	900.228000613813
11/3/2021	Coyote Creek	O. mykiss	23.6	126	982.126059709086
11/3/2021	Coyote Creek	O. mykiss	21.2	117	982.126059706528
11/3/2021	Coyote Creek	O. mykiss	689	380	900.228000613812
11/3/2021	Coyote Creek	O. mykiss	19.9	114	982.126059706515
11/3/2021	Coyote Creek	O. mykiss	-	151	900.228000613814
11/3/2021	Coyote Creek	O. mykiss	418	320	900.228000613816
11/3/2021	Coyote Creek	O. mykiss	26.7	127	982.126059706534
11/3/2021	Coyote Creek	O. mykiss	132.3	252	900.228000613815
11/3/2021	Coyote Creek	O. mykiss	14.0	104	982.126059706574

11/4/2021	Guadalupe Creek	O. mykiss	18.8	120	982.126059706522
11/4/2021	Guadalupe Creek	O. mykiss	5.8	78	982.126059706524
11/4/2021	Guadalupe Creek	O. mykiss	7.6	81	982.126059709109
11/4/2021	Guadalupe Creek	O. mykiss	6.1	81	982.126058146865
11/4/2021	Guadalupe Creek	O. mykiss	22.6	126	982.126058146880
11/4/2021	Guadalupe Creek	O. mykiss	52.8	171	900.228000613899
11/8/2021	Stevens Creek	O. mykiss	95.1	198	900.228000613898
11/8/2021	Stevens Creek	O. mykiss	11.6	95	982.126058146835
11/8/2021	Stevens Creek	O. mykiss	114	207	982.126058146870
11/8/2021	Stevens Creek	O. mykiss	11.2	96	982.126058146885

Stevens Creek 2020-2021 Adult Salmonid Migration Monitoring Using the Vaki Riverwatcher Passive Monitoring System at the Fremont Fish Ladder



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January 2022

Contents

Introduction 1
Methods 1
Installation, Operation, and Maintenance 1
Data Analysis 6
Results 6
Flow Conditions 6
Detections 6
Discussion 8
References 9

Figures

Figure 1. Stevens Creek Vaki Riverwatcher location. 3
Figure 2. The Vaki Riverwatcher system at the exit of the Fremont fish ladder A) looking upstream and B) looking downstream. 4
Figure 3. Vaki Riverwatcher fish counter. 5
Figure 4. Stevens Creek stream flow at ALERT gage 5035 (4.4 km downstream of Vaki) during the 2020-2021 Vaki monitoring season. Time periods when flow was present at the Vaki during inspections and the measured flow at those times are overlaid on the hydrograph. 7

Tables

Table 1. Flow measurements taken at the Stevens Creek Vaki during the 2020-2021 monitoring season. 7

Introduction

Steelhead (*Oncorhynchus mykiss*) in the Stevens Creek Watershed are in the Central California Coast (CCC) Distinct Population Segment (DPS), which were listed as threatened by the National Marine Fisheries Service (NMFS) in 1997. Valley Water is committed to monitoring this species under the Fish and Aquatic Habitat Collaborative Effort (FAHCE). FAHCE is a collaborative process to identify actions to balance fish and aquatic habitat needs with Valley Water's water supply operations. The program seeks to improve aquatic spawning and rearing habitat, as well as fish passage for migration to and from the watersheds of the Coyote and Stevens Creeks and Guadalupe River. In the 2021 water year, Valley Water implemented a pilot program of FAHCE flow measures (also called FAHCE rule curves) and began steelhead monitoring on Stevens Creek. Due to their protected status, Valley Water implemented a noninvasive means of documenting adult steelhead escapement in Stevens Creek using the Vaki Riverwatcher System (Vaki). The Vaki is a computer-based fish counter that employs scanner plates and a digital camera to capture videos and silhouette images of fish as they pass between the plates. The Vaki provides information on the occurrence and timing of adult fish migration both upstream and downstream through the counter.

The Stevens Creek Vaki unit was deployed at the top of the Fremont fish ladder in the City of Sunnyvale during the steelhead migration season. The fish ladder was constructed in the 1980s to enable fish passage around the concrete drop structure, which had previously created a barrier to fish migration. The 2020-2021 migration season was the first Vaki monitoring period at Stevens Creek and is the focus of this report.

Methods

Installation, Operation, and Maintenance

The Fremont fish ladder is located approximately 10 kilometers upstream of the South San Francisco Bay on Stevens Creek and immediately downstream of Fremont Avenue

in the City of Sunnyvale (Figure 1). The Vaki was installed at the Fremont fish ladder on December 10, 2020 and placed directly on top of the creek bed at the ladder exit (upstream end) oriented to prevailing flow (Figure 2). The channel was dry at the time of installation. The counter itself is a rectangular-shaped unit outfitted with scanner plates, a camera, and infrared light-emitting diodes on the interior (Figure 3). Due to its placement at the top of the ladder, adult migratory fish exiting the ladder are directed through the counter. When a fish swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the onsite computer. Other information recorded during each detection includes the speed the fish was traveling, the direction the fish was moving (upstream or downstream), body depth (for estimating length based on length-to-depth ratios from the literature), along with the date and time of the detection. A detection also triggers a digital camera that records a 4.1-second video for fish traveling upstream and a 14.4-second video for fish traveling downstream. The videos are used to confirm the presence of a fish and improve confidence in species identification.

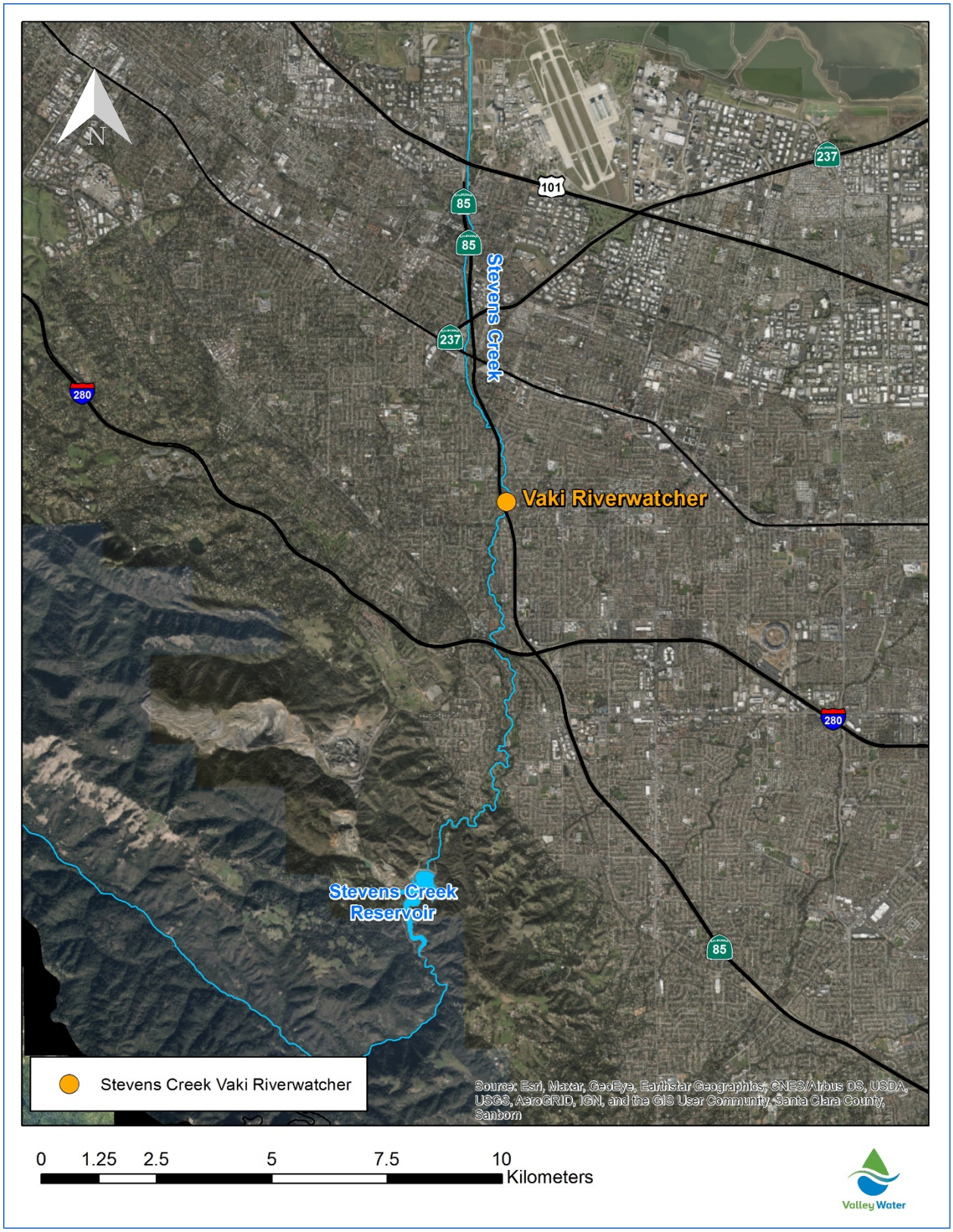


Figure 1. Stevens Creek Vaki Riverwatcher location.

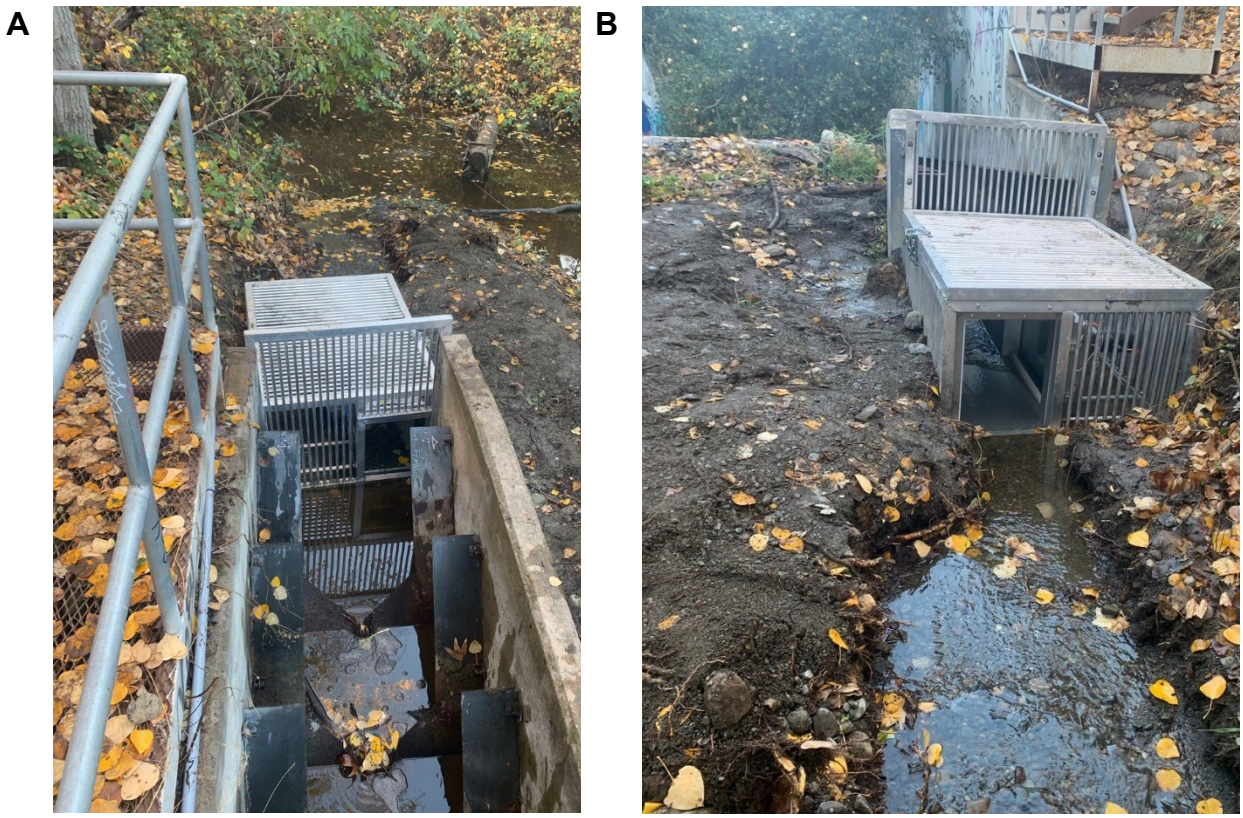


Figure 2. The Vaki Riverwatcher system at the exit of the Fremont fish ladder A) looking upstream and B) looking downstream.

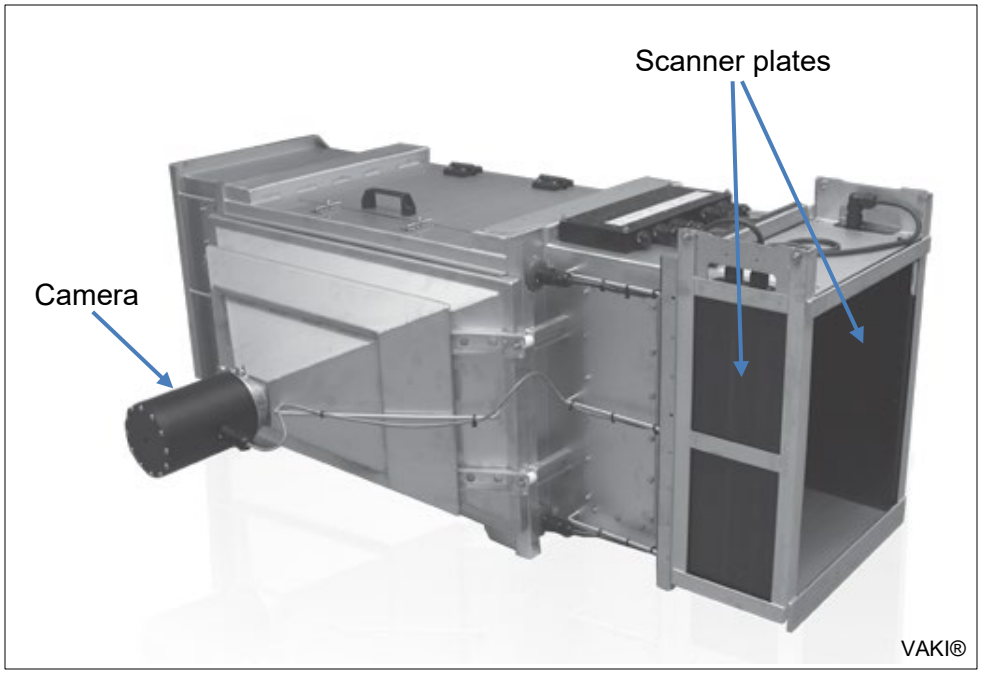


Figure 3. Vaki Riverwatcher fish counter.

All the data collected by the Vaki were stored on the attached onsite computer. Data was manually downloaded from the computer once a week and transferred to the Valley Water network. Once the data was downloaded, the onsite computer database was reset. The files were vetted by Valley Water staff as soon as possible following the download. During the weekly visits to download data, Valley Water staff also performed any necessary cleaning and maintenance. In addition to regular weekly maintenance, the Vaki was inspected within 48 hours prior to the start of a rain event with a 50% or greater chance of precipitation and within 48 hours after a rain event to ensure adequate fish passage through the facility and remove any accumulated debris.

The Vaki was powered by eight 6-volt batteries that were charged by a solar panel. No power outages or other malfunctions occurred during the 2020-2021 monitoring season.

The Vaki was powered off for the season on June 1, 2021 and removed from the creek on June 28, 2021. The creek was dry during the time period between the Vaki shutdown and removal.

Data Analysis

The Vaki recorded silhouettes and videos of all items large enough to break the plane of the diodes (body depth of 40 mm or greater). Scanned infrared silhouettes and video images were reviewed using the Winari software. Videos were used to identify detections to species when conditions provided clear images, and silhouettes were also used for species identification if distinguishing characteristics were present. Detections without accompanying videos were only sorted by species if the silhouette was clear and the confidence level of identification was high. All detections of species other than fish (e.g., mammals, birds) were placed into the “not fish” category.

Results

Flow Conditions

Water Year 2021 was an historically dry year. Rainfall totals were 5.5 inches at precipitation gage 6048, the lowest year on record for that gage. In addition, storage in Stevens Creek Reservoir remained low throughout the winter and spring and never reached the threshold to trigger FAHCE rule curve pulse flows. Stream flow on Stevens Creek over the course of the Vaki monitoring season in relation to time periods when water was present at the Vaki and flow measurements that were taken during inspections can be seen in Figure 4. Flow measurements taken at the Vaki are also provided in Table 1. Based on the Vaki inspections, flow was present at the site for at least 20 days; the channel was either dry or had isolated pools during all other inspection days.

Detections

No fish detections were recorded during the 2020-2021 monitoring season. Wildlife species were observed moving through the counter during dry periods and included bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), rat (*Rattus sp.*), gray squirrel (*Sciurus sp.*), and spotted towhee (*Pipilo maculatus*).

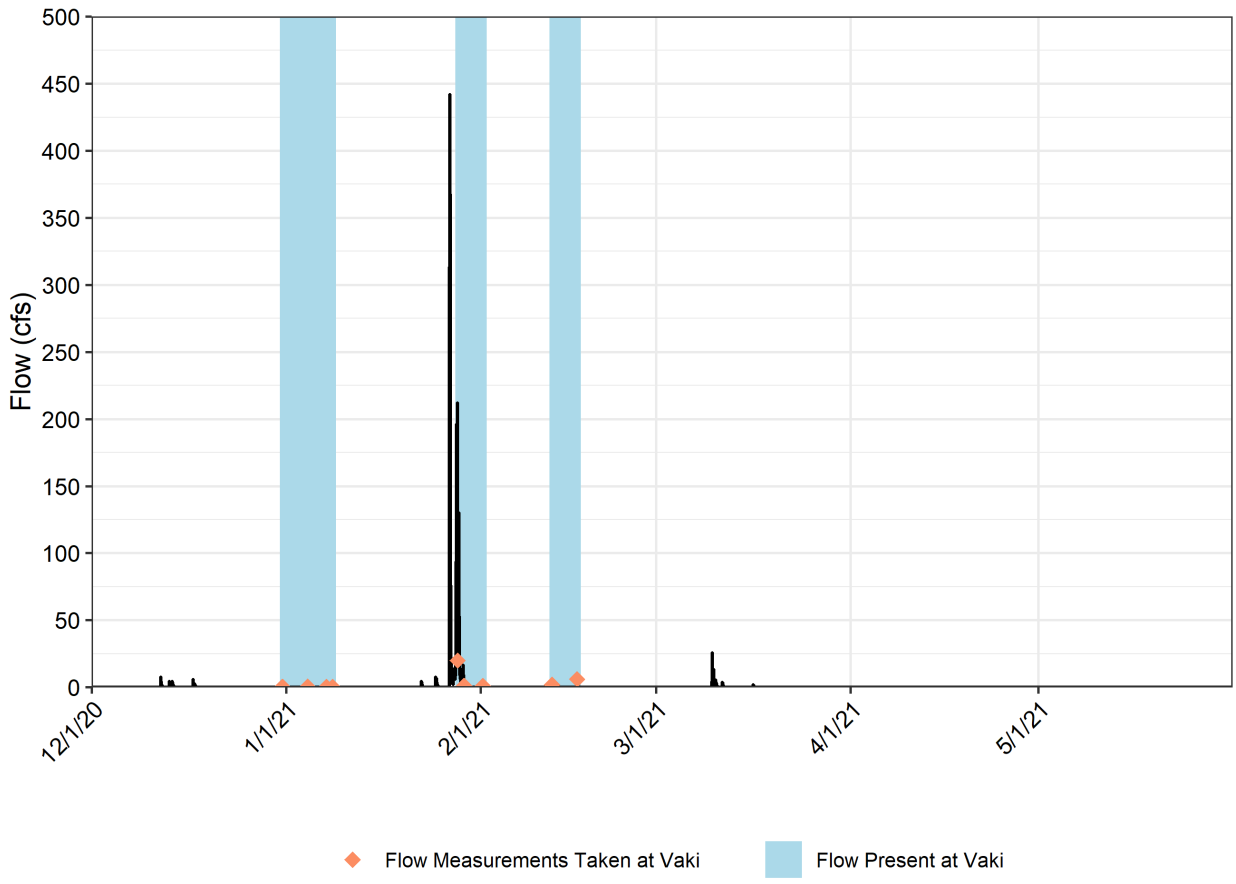


Figure 4. Stevens Creek stream flow at ALERT gage 5035 (4.4 km downstream of Vaki) during the 2020-2021 Vaki monitoring season. Time periods when flow was present at the Vaki during inspections and the measured flow at those times are overlaid on the hydrograph.

Table 1. Flow measurements taken at the Stevens Creek Vaki during the 2020-2021 monitoring season.

Date	Flow (cfs)*
12/31/2020	0.3
1/4/2021	0.6
1/7/2021	0.3
1/8/2021	0.3
1/28/2021	20.0
1/29/2021	1.2
2/1/2021	1.2
2/12/2021	2.0
2/16/2021	6.0

*Flow was measured within 1 foot of the ladder exit

Discussion

The absence of steelhead Vaki detections is likely a result of the limited precipitation and stream flow experienced on Stevens Creek during the 2020-2021 monitoring season. Though flow was present at the Vaki on three occasions during the adult steelhead migration period of December to April (Moyle 2002), it was short-lived, and it is possible that dry back or reduced flows occurred downstream and restricted fish passage to the ladder. The length and timing of the dry back area of Stevens Creek fluctuates year by year, depending on the annual hydrologic cycle, reservoir operations, and local groundwater conditions. In most years, Stevens Creek can be characterized as perennial for approximately 5.7 miles downstream of Stevens Creek Reservoir to around Fremont Avenue. The creek then dries seasonally and is intermittent from Fremont Avenue to 2 miles downstream to Central Avenue (AECOM and MLA, 2020). Thus, it is typical for the area around the Vaki Riverwatcher location to occasionally go dry, but the drought conditions during the 2020-2021 monitoring season exacerbated the dry back.

There were no power outages, periods of time when the Vaki was non-operational, or issues with video clarity; therefore, detection of adult steelhead was possible during the entire monitoring period. However, the Vaki Riverwatcher is not designed to track the movement of juvenile *O. mykiss*, which may have gone undetected during the monitoring season when flow was present. The small size of the juvenile fish allows them to potentially swim through the weir bars outside of the Vaki, through the scanner plates without triggering the diodes and avoid detection, or over the drop structure and not through the system whatsoever.

The 2020-2021 Vaki monitoring season overall had both limited precipitation and limited stream flow, thus reducing opportunity for upstream passage of adult steelhead. Based on the results of the Vaki monitoring, it is unlikely that any steelhead migrated upstream of the Fremont fish ladder during the 2020-2021 migration season. In years with flow conditions more suitable for passage, we will be better able to assess the effectiveness

of the Vaki for monitoring steelhead migration on Stevens Creek.

References

AECOM and MLA (Michael Love & Associates). 2020. Stevens Creek Fish Passage Analysis. Prepared for Valley Water. June.

Moyle, P. B. (2002). *Inland fishes of California*. Berkeley: University of California Press.